TRANSACTIONS

OF THE

CONNECTICUT ACADEMY

OF

ARTS AND SCIENCES.

VOLUME XI.

(CENTENNIAL VOLUME.)

NEW HAVEN:
PUBLISHED BY THE ACADEMY.
1901–1903.

THE TUTTLE, MOREHOUSE & TAYLOR COMPANY.

The Academy regrets to announce the death of Professor Josiah Willard Gibbs.

Professor Gibbs was born in New Haven, Conn., February 11, 1839, and died April 28, 1903.

At the regular meeting of the Academy held May 13, the following minute on the death of Professor Gibbs was unanimously adopted :

The Academy has learned with the deepest regret and sorrow of the death of its most distinguished member, Professor Josiah Willard Gibbs, and desires to place on record its deep sense of the loss sustained by the whole scientific world, and in an especial degree by the members of this body.

The first published investigations of Professor Gibbs appeared in the Transactions of this Academy in 1873, under the titles of "Graphical Methods in the Thermodynamics of Fluids," and "A Method of Geometrical Representation of the Thermodynamic Properties of Substances by means of Surfaces," and these were followed, in 1875 and 1878, by his celebrated papers on "The Equilibrium of Heterogeneous Substances." The great importance of this work is shown
y the fact that the author anticipated, by purely theoretical
nsiderations, a large number of the discoveries in Physical
mistry which have since been made, and that he intro-
l, into this field, the most powerful method of theoreti-
estigation now known :—a method, moreover, which,
ndependent of special hypotheses, seems destined to
rmanent place among those great scientific methods
lapse of time does not render obsolete. The
emphasizing, in this memorial, the researches of
bs published in its Transactions, is not unmind-
nguished achievements in other scientific lines,
others the special mention of such work,
that it recognized so early the value of his
odynamics, and was instrumental in giv-
scientific world.

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NTENTS OF PART II.

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CONTENTS.

Note: Part IV, Geology; and Part V, Marine Zoölogy, are to appear in another volume.

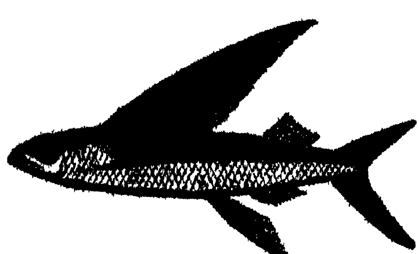

Figure 243.—Bermuda Flying Fish.

Figure 244.—Ancient inscription on "Spanish Rock," after Lefroy, 1879. It has been attributed by most writers to Ferdinando Camelo, a native of Portugal, who received an abortive charter for the settlement of Bermuda from the King of Spain, about 1527. But there is no evidence that he ever visited the islands. If the monogram ever stood for his name the C has now disappeared by weathering Quite possibly this has happened At present, the monogram more resembles TK or FK It is more probable that it is the only known record of the survivors of some disastrous shipwreck in 1543, who may have lived for some time on these islands, and perhaps died here. Possibly only a single individual survived, and he may have lived alone for years, like "Robinson Crusoe." The presence of a cross would rather exclude the theory that it was left by pirates or buccaneers

This is probably one of the mementoes of the supposed visits of the Spanish before the English settlement, mentioned by Gov. Butler, in 1619: "Witnesse certaine crosses left erected upon rocks and promontories" He also refers to old Spanish coins that had been found here by the early settlers.

The inscription, which was originally deeply cut in the limestone ledge, is gradually becoming less distinct, due partly to weathering and partly to vandalism of visitors. A cast of it is preserved in the Public Library, at Hamilton.

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INDEX TO PART I.

ERRATA.

Page 28, line 6 from bottom, for *Dolabrifera*, read *Dolabrifera.*

Page 48, line 20, for lix read lxix

Page 51, line 39, for Flagg's read Flatt's.

Page 52, line 15, for 1901 read 1900.

See also page 62.

Page 68, line 10 from bottom, for Vaughan, read Gregory

Page 69, line 5, for Pl. xii read Pl xiv.

Page 98, line 22, for T read F.

Page 113, line 8 from bottom, for Eusmillidæ read Eusmilidæ.

Page 114, under cut, and p. 170, line 25, for *Eusmillia* read *Eusmilia.*

Page 126, line 22, for Pl. xxi read Pl. xxv.

Page 128, line 17, for Pl. xxxiii, fig. 4 read Pl. xxv, fig. 3.

Page 129, last line, for 4551 read 4544.

Page 137, line 17, for *turgida* read *turgidum.*

Page 145, line 8 from bottom, for type read types.

Page 149, line 7, for *Danai* read *Danæ.*

Page 151, line 1, for 400^{mm} read 240^{mm}, for 150^{mm} read 195^{mm}

Page 184, line 24, for *Cryptobacia* read *Cryptabacia*, and for *Podobacia* read *Podabacia.*

Page 190, line 15, for 4557 read 4587.

Page 194, line 9, for 4543 read 4518.

Page 200, line 18, for 81 read 80 ; and line 20, omit No. 1901.

Page 202, line 9, for Fig. 1 read Fig. 2 , and line 12, for Fig 2 read Fig. 1.

Page 203, line 33, for 1487 read 1489.

Page 204, line 23, omit No. 1901 , and line 24, for West Indian read Florida.

Page 245, line 6, for 3063 read 3063*a*.

Page 257, line 25, for 4187 read 4167.

Page 262, last line, for 3063 read 3063*a*.

Page 264, line 4, for 3063 read 3063*a* ; and line 38, for 220 read 222.

Page 265, line 8 from bottom, for 1686 read 1688.

See also page 266.

Page 268, line 2 from bottom ; page 272, line 6 ; page 273, line 28 , page 274, line 3 from bottom, for Goslin read Gosling.

Page 280, line for *triangulata* read *triangulatus.*

Page 282, line 29, for 3194 read 3255.

Page 351, line 34, for Giard 1872 read Verrill 1871.

Page 354, line 20, for 9 read 20.

THE CONNECTICUT ACADEMY OF ARTS AND SCIENCES.

CENTENNIAL ANNIVERSARY, OCTOBER 11TH, 1899.

NORTH SHEFFIELD HALL

AFTERNOON SESSION, 3 P. M.

1. Reading of Communications from Corresponding Societies, by ALEXANDER W. EVANS, Ph.D., Secretary of the Academy.
2. Address of Welcome, by His Honor LYMAN A. MILLS, Lieutenant Governor of Connecticut.
3. Address; The Debt of this Century to Learned Societies, by Professor WILLIAM H. BREWER, Ph.D., President of the Academy.
4. Address; Scientific Thought in the Nineteenth Century, by Professor WILLIAM NORTH RICE, LL.D., of Wesleyan University.

[At the close of the addresses an opportunity will be offered for oral communications from delegates of Corresponding Societies.]

EVENING SESSION, 8 P. M.

5. Address; The History of the Academy during its First Century, by Hon. SIMEON E. BALDWIN, LL.D.

Reception by the Academy of delegates from Corresponding Societies and invited guests, in Winchester Hall, from 9 to 11 P. M.

With the above program the Connecticut Academy of Arts and Sciences, the third in age of the learned societies of America, celebrated on the 11th of October, eighteen hundred and ninety-nine, its one-hundredth anniversary. By a happy coincidence the Centennial of the Academy came into near conjunction with the Bicentennial of Yale University, the foster-parent of the

Academy, but at the same time was far enough removed to escape occultation.

In the absence of his Excellency the Governor of Connecticut, who had official engagements elsewhere, the Lieutenant Governor, Hon. Lyman A. Mills, welcomed the Academy and its guests in the name of the State.

The addresses of the occasion, by the President of the Academy and two of its honored members, are printed in the pages that follow. Both to Judge Baldwin, of the Supreme Court of Connecticut, who drew so faithful a picture of the Academy's past, setting it in just relation to its environment and making even its more humble details attractive, and to Professor Rice, of Wesleyan University, who so admirably outlined the course of scientific thought in the nineteenth century, the Academy is under great obligation for the service rendered.

The cordial greetings received from the correspondents of the Academy at home and abroad, conveying congratulations on the work achieved in the past and good wishes for the future, added much to the interest of the occasion. Their number and wide distribution, as shown in the subjoined list, bear witness to the sympathy which in this age unites the workers in science of all lands.

Johns Hopkins University,	Baltimore.
Boston Society of Natural History,	Boston.
Harvard University,	Cambridge.
Field Columbian Museum,	Chicago.
Connecticut Historical Society,	Hartford.
Trinity College,	Hartford.
State Historical Society of Wisconsin,	Madison.
Wesleyan University,	Middletown.
New London County Historical Society,	New London.
Linnean Society of New York,	New York.
New York Academy of Sciences,	New York.
American Philosophical Society,	Philadelphia.
Franklin Institute,	Philadelphia.
Pennsylvania Historical Society,	Philadelphia.
Missouri Botanical Garden,	St. Louis.
Academy of Science,	St. Louis.
Essex Institute,	Salem.
Georgia Historical Society,	Savannah.
Smithsonian Institution,	Washington.
United States Naval Observatory,	Washington.

Koninklijke Akademie van Wetenschappen,	Amsterdam.
Naturforschende Gesellschaft,	Basel.
Bataviaasch Genootschap van Kunsten en Wetenschappen,	Batavia.
Koninklijke Natuurkundige Vereeniging in Nederlandsch-Indie,	Batavia.
Königlich Preussische Akademie der Wissenschaften,	Berlin.
Government Observatory,	Bombay.
Meteorologisches Observatorium,	Bremen.
Naturwissenschaftlicher Verein,	Bremen.
Queensland Branch of the Royal Geographical Society of Australasia,	Brisbane.
Académie des Sciences, des Lettres et des Beaux-Arts de Bélgique,	Bruxelles.
Institut Météorologique de Roumanie,	Bucharest.
Société Linnéenne de Normandie,	Caen.
Asiatic Society of Bengal,	Calcutta.
Kongelige Frederiks Universitet.	Christiania.
Koninklijk Nederlandsch Meteorologisch Instituut,	De Bilt.
Naturforscher-Gesellschaft bei der Kaiserlichen Universität,	Dorpat.
Verein für Erdkunde,	Dresden.
Royal Observatory,	Edinburgh.
Naturforschende Gesellschaft,	Emden.
Naturforschende Gesellschaft,	Freiburg im Breisgau.
Naturforschende Gesellschaft,	Gorlitz.
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Societas pro Fauna et Flora Fennica,	Helsingfors.
Medicinisch-Naturwissenschafliche Gesellschaft,	Jena.
Société Physico-Mathématique,	Kasan.
Naturwissenschaftlicher Verein für Schleswig-Holstein,	Kiel.
Physikalisch-ökonomische Gesellschaft,	Konigsberg.
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Mathematical Society,	London.
Royal Historical Society,	London.
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Geological Survey of Canada,	Ottawa.

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Società Italiana delle Scienze detta del XL, .	Rome.
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Comité Géologique, ...	St. Petersburg.
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Russisch Kaiserliche Mineralogische Gesellschaft,	St. Petersburg.
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Royal Society of New South Wales. . .	Sidney.
Museum, ...	Trömso.
Reale Museo di Zoologia e di Anatomia Comparata,	Turin.
Konglige Universitet, ...	Upsala.

From these greetings we venture to select for reproduction here, on the ground of our inheritance of a common language and of other common heritages, the following:

THE ROYAL SOCIETY OF LONDON

FOR IMPROVING NATURAL KNOWLEDGE

Sends to the Connecticut Academy of Arts and Sciences on the happy occasion of its celebrating the Centenary of its foundation brotherly greetings and hearty congratulations.

From the earliest days the Royal Society has felt that its efforts should not be confined to the city whose name forms part of its title, and has always sympathized with, and, from time to time, has assisted undertakings for improving Natural Knowledge carried out in various parts of the world. It remembers with pride how since its early years it has been able to count as members of itself many distinguished men of science dwelling on the other side of the Atlantic, some of whom Connecticut can claim as its own.

And to the earnest wish that the Connecticut Academy of Arts and Sciences may enjoy continued prosperity in time to come it adds the no less sincere and earnest wish that the brotherly ties between those who on the two sides of the ocean are devoting themselves to improving Natural Knowledge may grow still stronger as the years pass on.

LISTER,

Pres. R. S.

THE LONDON MATHEMATICAL SOCIETY

Present fraternal greetings to the Connecticut Academy of Sciences on the occasion of the hundredth anniversary of their foundation.

They look back with satisfaction on the exchange of publications which has subsisted between the two bodies ever since their own foundation in the year 1865.

They recognize with much pleasure the importance of the researches in Mathematical and Physical Science given to the world by the Connecticut Academy in a language which does not convey to them any suggestion of a foreign origin. In no country has the value of these researches been earlier or more fully recognized than in Great Britain.

They desire and expect a long career of increasing usefulness and honor for the Connecticut Academy of Sciences, which even now takes rank among the most ancient of the existing learned societies of the world.

Signed in behalf of the London Mathematical Society.

KELVIN, *President.*
JOSEPH LARMOR, *Treasurer.*
ROBERT TUCKER, } *Secretaries.*
A. E. H. LOVE, }

London, July 31, 1899.

THE COUNCIL OF THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY

Send most cordial greetings on the occasion of the Centenary of the Connecticut Academy of Arts and Sciences.

They recall the great services which the Academy has rendered, not only in the encouragement of scientific research within its own borders, but also by the singular merit of its publications, many of which they feel will rank as permanent landmarks in the history of Science.

The Council feel that they can express no better wish than that the Academy may continue to flourish in a manner worthy of its past traditions.

26th September, 1899.

HORACE LAMB, *President.*
R. G. GWYTHER, } *Honorary*
FRANCIS JONES, } *Secretaries.*

ROYAL OBSERVATORY, EDINBURGH.

27th September, 1899.

To the Secretary Connecticut Academy of Arts and Sciences, New Haven, Connecticut, U. S. A.

DEAR SIR—The Staff of this Observatory desire to join with me in most heartily congratulating the Connecticut Academy of Arts and Sciences on the celebration of the hundredth anniversary of its foundation.

On this auspicious occasion we particularly call to mind the distinguished services to the Sciences of Meteorology and Astronomy done by your illustrious members Loomis and H. A. Newton, whose names will ever be associated with the scientific progress of the closing century.

Wishing the most complete success to your commemoration and regretting that it is not practicable for any of us to share personally therein, I am, Dear Sir,

Very faithfully yours,

RALPH COPELAND.

In addition to the greetings sent, several of the societies had also appointed delegates to represent them at the Celebration, delegates of foreign societies being naturally chosen from their American membership. Some who had accepted appointment found themselves at the last moment unable to come. Actually present were these: from the Boston Society of Natural History, Professor Edward S. Morse; from Harvard University, Professor Charles R. Lanman; from the Connecticut Historical Society, Hon. Simeon E. Baldwin; from Wesleyan University, Professor William North Rice; from the Geological Society of London, Professors George J. Brush and Edward S. Dana; from the Literary and Philosophical Society of Manchester, Professor J. Willard Gibbs; from the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, Mr. Richard P. Rothwell, of New York.

With a reception tendered by the Academy to the delegates and invited guests, the celebration, and with it the record of the first century, was closed.

THE FIRST CENTURY OF THE CONNECTICUT ACADEMY OF ARTS AND SCIENCES.

An Historical Address delivered before the Academy at its Centennial Anniversary, on October 11th, 1899.

By Simeon E. Baldwin, LL.D.

American science, and perhaps we may say American letters, first began to take shape in the latter half of the eighteenth century. Franklin was easily the first in each One is almost tempted to declare that he was the first American who wrote good English: it is certainly safe to say that he was the first whose style of composition had a distinct and lasting charm. This gave wings to his scientific discoveries and conclusions, and made him a citizen of the world.

It was natural that he should take the lead in introducing upon our continent the learned academy.

The American Philosophical Society sprang from his creative touch, and had its first beginnings at Philadelphia in 1744. Boston followed in 1780 with the American Academy of Arts and Sciences, and the list for the century was closed at New Haven with the Connecticut Academy of Arts and Sciences in 1799.*

It is seldom that anything enduring is originally constituted in the form and manner which subsequently mark its character.

In laying the foundations of the oldest of the societies which I have named, which was in 1743, it was Franklin's aim to bring into association all who had any reputation for scientific attainments in the different colonies. While an organization was effected in 1744, no one came in, outside of Pennsylvania, New York and New Jersey, and after a languishing existence of a quarter of a century it was merged with a local society of Phila-

* An association called "The Society for Promoting Useful Knowledge" existed in the city of New York in 1792, which met monthly; but it was not incorporated. Morse's *American Geography*, ed. of 1792, 265.

delphia under a charter from the State of Pennsylvania, incorporating it as the American Philosophical Society for the Promotion of Useful Knowledge. Of this Franklin was the first President, and it has ever since maintained an honorable position in the republic of letters.

In like manner the Academy, whose centennial we meet to-night to celebrate, was founded on the ruins of an earlier organization, the Connecticut Society of Arts and Sciences. In 1779, Benjamin Guild, a Harvard tutor, who was then planning the foundation of the American Academy at Boston, on his way back from Philadelphia, where he had probably made himself acquainted with the constitution and methods of the American Philosophical Society, stopped over at New Haven to see one of its early members, President Stiles. The establishment of academies both at Boston and New Haven was talked over at length, and each soon made earnest efforts in that direction. A few months later, Mr. Guild was able to send Dr. Stiles a copy of the charter granted by Massachusetts for the American Academy of Arts and Sciences. In Connecticut, however, a less friendly spirit was shown. The relations between the State and Yale College were somewhat strained. That institution had become a body of great and growing importance. It was self-governing. The fellows or trustees were all Congregational clergymen, and perpetuated themselves by filling vacancies, as they might arise. No power of visitation had been reserved in terms to the State, when the charter was granted, and none was admitted to exist by the College authorities. It was obvious that any academy of arts and sciences which might be incorporated would naturally gravitate towards the College, and come ultimately under the leadership of the same set of men.

There were those also, even among the Congregational clergy, by whom the College was viewed with some distrust. President Clap had been a Calvinist of the old school, but President Stiles was what in those days was denominated a Latitudinarian. He was of opinion that the true theory of Christian redemption was that—to use his own words in a letter to Dr. Franklin—a "happy immortality" had thus been "purchased for the virtuous and truly good of every religious denomination in Christendom, and for those of every age, nation and mythology, who reverence the

Deity, are filled with integrity, righteousness, and benevolence."* Such sentiments did not generally prevail in the Congregational pulpits of the State, and those who did not share them were able to point to the declining state of the College church as evidence of their evil tendency.

Under these circumstances a charter for "the Connecticut Academy of Arts and Sciences," drafted by President Stiles, was sent by him to the Rev. Dr. Nathan Strong of Hartford for presentation to the General Assembly at its May session, to be held in that city in 1781. The Academy was to consist of a President and Fellows, the first meeting to be called by Dr. Stiles and held at "the chapel of the College of Connecticut Hall in New Haven." A blank was left in the draft for the names of the incorporators, which it was probably supposed could best be filled by Dr. Strong on consultation with the friends of the measure in the Assembly. Apparently it found friends in the upper house, for it was there passed, and with such inconsiderate haste that the blank was left unfilled, thus making the bill totally inoperative. In the lower house it received more careful attention. An amendment was proposed to make the Academy "at all times subject to the visitation and inspection of the General Assembly" and the matter continued to the next session at New Haven.† In this disposition of it the upper house finally concurred, and after one or two similar continuances at subsequent sessions, Dr. Stiles evidently thought it best to make a fresh start on a different basis, for we find him, in 1783, in consultation with his cousin, Rev. John Devotion of Saybrook, over a new charter, for the "Connecticut Academy of Sciences," making the Governor of the State the first President, and the Secretary of the State the "chief Secretary." The Academy was to have power to establish a botanical garden and to purchase or erect a suitable building, containing a hall for its meetings, a library, and rooms adapted to the purposes of a museum. The first meeting was to be held at Middletown.‡

* Franklin's Memoirs, Phila. ed. of 1834, i, 622

† Conn. State Mss Archives, Colleges and Schools, 1763–1789, No 184 The Yale Book, I, 331.

‡ Mss. Diary of President Stiles, Vol. 11, p 282. This draft of a charter is also preserved in the Stiles Mss., in the Yale library.

A sedulous desire to avoid any marked connection with the College is shown in this scheme of organization. The arts were even excluded from the corporate name. It fared, however, no better than its predecessor; one cause perhaps, being that it provided that the proposed building should be free of taxation. The public mind, also, was full of other things. The era of the revolution had closed, but that of reconstruction, with all its possibilities, was now opening.

Three years later, in despair of obtaining the legislation desired, a voluntary association* was formed at Hartford during the session of the General Assembly there, by the name of the Connecticut Society of Arts and Sciences. Dr. Stiles and Dr. Strong were among its active promoters, the number of whom was limited to sixty, and soon rose to over forty, the Lieutenant-Governor of the State being the first President. It was to have two semi-annual sessions, alternately at Hartford and New Haven, during the session of the legislature at each place.

No prophet was needed to predict the practical failure of this scheme. It was an appendage to the General Assembly, but without its countenance. It had no fixed center nor place of abode.

A learned academy must be the outgrowth, or at least must have the cordial support, either of a university or of a capital. It must draw its life from an exchange of the fruits of scholarship, or an exchange of news of scientific discovery. Nor can it be migratory. It must have a ποῦ στῶ, if it would exert a continuous and lasting influence.

But one paper was ever published by the Connecticut Society of Arts and Sciences—a dissertation on the Language of the Muhhekaneew Indians, by Rev. Dr. Jonathan Edwards, the younger. It is one of acknowledged merit, and was communicated to the Society in October, 1787.

The times were then growing more and more unfavorable to the cultivation of any science but that of politics.

The one great subject of thought was the formation of a better government for the United States. The Convention which

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* Stiles' Diary, Vol. 10, p. 150. A search through the Journal of the May Session, 1786, confirms the accuracy of Dr. Stiles' entry as to its not being incorporated.

framed the Constitution of 1789 had just closed its sessions. Whether to ratify or reject the work, whether to side with Hamilton or Patrick Henry, were questions which quite superseded any that could be raised by Dr. Edwards as to the analogy between the Hebrew and the tongue of the Muhhekaneews. Party spirit soon awoke, and whatever time Connecticut could give to academic subjects was devoted to readjusting the relations between the State and Yale College by bringing the Governor, Lieutenant-Governor, and six of the Assistants into her board of management.

This was accomplished in 1792, and seven years later, on March 4th, 1799, a new organization was quietly effected at New Haven, under the name originally selected by Dr. Stiles. It was at first a voluntary association, but a few months later, at the October session of the General Assembly, in 1799, a charter of incorporation was easily obtained. It included many of the members of the Connecticut Society of Arts and Sciences, but there was no formal merger of the moribund institution with that thus brought into existence.

The first meeting of the Academy under its charter was held at the State House in this city on October 22d, 1799.

There was an organization on a solid foundation. The President was the President of Yale College. The Vice-President was the Governor of the State, and the head of the "Counselors" was the Lieutenant-Governor; both also being *ex officio* Fellows of the College. The charter did not specify the objects of the Academy, otherwise than by its name, and in the preamble, which declared that "literary Societies have been found to promote, diffuse and preserve the knowledge of those Arts and Sciences, which are the support of Agriculture, Manufactures, and Commerce, and to advance the dignity, virtue and happiness of a people." These same words were repeated in the charter of the American Geological Society, when that was incorporated by Connecticut, twenty years later.*

Any organization of which President Dwight was the head had from that fact alone an assurance of success. His strong, dominating character, active mind, and untiring energy, set the Academy at once upon a course of useful activity.

* Private Laws of Connecticut, Vol. 1, p. 1098.

New Haven was but a small capital. Yale was but a small college. But there were then few larger cities, and only one larger college on the American continent.

The membership of the Academy was co-extensive with the State, and embraced men of all parties and all shades of opinion. Among those named in the charter were Chief Justice Swift of Windham, whose treatises on legal topics were among the earliest as they are among the best of American works of that character; Josiah Meigs, an ardent Jeffersonian, then holding the chair of Mathematics and Natural Philosophy at Yale, but soon to find a more congenial political atmosphere in Georgia, where he went in 1801 to become President of its State University; Noah Webster; Abraham Bishop, whose attacks on President Dwight in political addresses soon put an impassable gulf between them; Chief Justice Hosmer of Middletown; Judge Pierpont Edwards; Chief Justice Ellsworth of Windsor; and Dr. Bela Hubbard, rector of Trinity Church, and the leader of the Episcopalian clergy of the diocese.

President Dwight was particularly interested in political science. He was also a close student of history, and saw the importance for the United States of reducing to proper form for future use all the historical and statistical material that, so familiar as to be uninteresting to one generation, is of priceless value to the next.

Under his lead, in December, 1799, action was taken towards memorializing Congress to enlarge the objects of the national census of 1800, and to secure greater particularity in the returns. Coöperation in this effort was invited from the American Philosophical Society and the American Academy of Arts and Sciences.

The Academy also, a week later, agreed on a circular letter to be issued in its name, asking for statistical information as to the State of Connecticut and the several towns within its jurisdiction. The result of this request, which was followed up by newspaper addresses, and much private correspondence, was that such statistics were obtained from more than thirty towns;* by far the most valuable being those for New Haven prepared by President Dwight. This piece of his work was published by the Academy in 1811, in a pamphlet of 84 pages, as the first part of the first

* The Yale Book, I, 333.

volume of a series to be entitled "A Statistical Account of the Towns and Parishes in the State of Connecticut." It was followed, in 1815, by a similar account of the towns in Litchfield county, by James Morris, and in 1819, by one of those in Middlesex county, by Rev. Dr. David Dudley Field of Haddam, father of an illustrious family. To this work Dr. Field added in 1827 a sketch of the history of Guilford and Madison.* It is to be regretted that the projected series was carried no farther.

During its first twenty years of existence, the Academy held its annual meetings at the State House in New Haven, and its others at the residences of its members in succession. An oration by some person of distinction was a feature of the annual meeting, and at those held at private houses some paper of a less formal character was generally presented, or topics of general interest discussed. If one of the members was writing a book, some of the chapters would be likely to pass in this way, while in manuscript, before the Academy, and the views presented receive its friendly criticism. President Dwight's defence of the common language of New England, and of the pronunciation of English by her people, contained in a letter to an imaginary Englishman, published after his death in the fourth volume of his "Travels in New England and New York," was presented in this way as a communication to the Academy in 1813.

In 1818, a report was adopted from a committee of which Professor Silliman was the chairman, urging the importance of a proper geological survey and map of the State. This was the beginning of an effort to press the subject upon the attention of the legislature, which resulted, in 1835, in the appointment by the State of two members of the Academy, Dr. Charles Upham Shepard and Dr. James G. Percival, to undertake the work. Dr. Shepard's report, which was mainly confined to mineralogy, was published in 1837, in a thick pamphlet of 188 pages, and Dr. Percival's, with the geological map, followed five years later in a volume of much larger dimensions.

The published transactions of the Academy, aside from the Statistical Account of the State, which was designed to stand by itself as a separate work, began with Part 1 of Volume 1, printed

* This was the foundation of Smith's History of Guilford, published in 1874.

in 1810. The second part followed in 1811, the third in 1813, and the fourth and last in 1816. The range of subjects discussed was broad. Two papers read by Noah Webster in 1799 and 1806 had the place of honor, and treated of the supposed moderation in the temperature of winter in modern times. It was his opinion that the spread of population over the earth, and the attendant alterations in the face of the ground occasioned by clearing and cultivation, had resulted in a less equal and uniform distribution of heat and cold among the several seasons, but that the cold of winter was in the aggregate as great as ever, though less steady. Judge Daggett narrated the history of a law suit brought for destroying a dam across the Housatonic river, in which the defence was that ponding the water had been a cause of fever and ague. A lengthy paper by Dr. Benjamin W. Dwight, of Catskill, New York, a son of the President, on Chronic Debility of the Stomach, excited wide attention, and was republished in England. One of its positions might well commend it to English readers. "Wine, and wine only," he wrote, "is recommended in holy writ for dyspeptic complaints. 'A little wine for thy stomach's sake, and thine often infirmities' was the direction of the Apostle Paul to Timothy. The words 'thy stomach's sake, and thine often infirmities' prove the disease to have been Chronic Debility of that viscus, with a numerous train of morbid sympathies; and no prescription of Hippocrates could have been better."

Another son of the President, Sereno E. Dwight, then a member of the New Haven Bar, contributed a dissertation on the Origin of Springs. The volume closed with a mathematical demonstration of Stewart's Properties of the Circle, by Professor Strong of Hamilton College. It contained also a number of papers on subjects of natural philosophy, and two from the pen of President Dwight, the more important one being Observations on Language, the theme of which was that the intelligence of any nation may be exactly estimated from its vocabulary.

The year after the completion of Volume 1 of the Memoirs of the Academy (which was the style of the title adopted) President Dwight's death sent the Presidency of the College, and with it naturally that of the Academy, into the hands of Dr. Day.

His horizon was not so broad as that of his predecessor in these offices, nor his executive powers of equal energy.

Another circumstance also now occurred to weaken the position of the Academy as an active force in the cultivation of the Arts and Sciences. In 1818, Professor Silliman undertook the arduous task of editing and publishing a scientific periodical of a general character, and in July of that year, the first number of the "American Journal of Science and Arts" appeared from the New Haven press. He had made important contributions to the first volume of the Academy's Memoirs, and had always been one of its leading spirits. Such, indeed, he continued to be for many years, but his main interest henceforth as to scientific publications was naturally centered in the Journal, for whose regular issue he had become responsible, and which was soon called, in common parlance, by his name. To support his undertaking, a vote had been passed in February, "that the Committee of Publication may allow such of the Academy's papers as they think proper, to be published in Mr. Silliman's Scientific Journal."

Free use was made of this authority, and a large part of the contents of the Journal was for many years drawn from this source. In some cases this fact was noted in publication; but in most it was not. Among the more important communications to the Academy which were thus transferred to the Journal of Science may be mentioned a series of articles, some by Edward C. Herrick, and others by Professors Olmstead and Loomis, stating the observations and conclusions which did so much to call general attention to the periodicity of meteoric showers and to confirm what is now the universally accepted theory of their cause.

In 1826, when the Journal was in great need of financial support, the Academy further voted to pay for a year the cost of printing such of its papers as might be published in it. In Baldwin's Annals of Yale College,* published in 1831, it is described as a publication "honorable to the science of our common country," and having "an additional value as being adopted as the acknowledged organ of the Connecticut Academy of Arts and Sciences."

The Christian Spectator, also, another New Haven magazine, which was founded in 1819, drew heavily from the productive

* P. 207.

force of the Academy. That, and its successors, the New Englander, and the Yale Review, were always mainly conducted by our members. The Spectator and the New Englander both cultivated political as well as theological science, and spoke on most of the subjects which from time to time commanded public attention. The Review has confined itself mainly to matters of politics and economics.

The last of the regular series of annual orations was delivered by Professor A. M. Fisher, in 1818. In 1819, the annual meeting, instead of taking place at the State House, was held at the residence of President Day, and in 1820, the day of it falling in the College vacation, when the Secretary was absent from town, none was called.

The Academy was now fast becoming a mere local literary society, and, if the truth must be told, but a languishing one at that. Its meetings were often without a quorum, and it seemed to have lost its life and spring. As a feeder to the American Journal of Science, it served a useful purpose; as a center of social intercourse it served another: but neither was the appropriate function of an academy of arts and sciences. That must not only do something: it must publish its doings, or die.

In 1833, an earnest effort was made to place it upon a better foundation, by dividing up the field which it sought to cover into distinct departments, and confiding each to a standing committee for regular inquiry and report. Early in 1834 such committees were appointed, and their arrangement was as follows:

On Mathematics and Natural Philosophy: Professor Olmstead, chairman.

On Chemistry and the kindred sciences, including Mineralogy and Geology: Professor Silliman, chairman.

On Botany and Zoology: Mr. C. M. Shepard, chairman.

On Medical Science: Professor Charles Hubbard, chairman.

On Intellectual Science: President Day, chairman.

On Law and Political Science: Judge Daggett, chairman.

On Theological Science (inclding Sacred Literature, Ecclesiastical History, Natural and Revealed Religion, Homiletics, Liturgies, Canon Law): Rev. Dr. James Murdock, chairman.

On Historical Science (including History, Geography, Chronology, Antiquities and Statistics): Dr. Noah Webster, chairman.

On Philology and Criticism: Professor Kingsley, chairman.

On *Belles-Lettres*: Professor Goodrich, chairman.

On the Fine Arts: H. Augur (the sculptor), chairman.

On Education: Professor Woolsey, chairman.

On these committees appeared the names of a number of non-resident members, including Professors Lathrop of Hamilton College, New York, Fowler of Middlebury College, Vermont, and Mitchell of Chapel Hill College, North Carolina, Rev. J. P. Cowles of Princeton, Massachusetts, and Professor Ethan A. Andrews of Boston.

The scheme was too ambitious, and little was accomplished by it.

A specialization of research of another character was commencing at Yale, which was perhaps more in accordance with the spirit of modern scholarship, but was destined to exert an unfavorable influence on the fortunes of the Academy. I refer to the formation of particular societies for the promotion of particular sciences. One of the earliest was the Yale Natural History Society, which achieved considerable results, particularly through the investigations of James Harvey Linsley of Stratford, whose catalogue of the Mammalia of Connecticut, and of the Shells of Connecticut, prepared for its service, were afterwards published in the American Journal of Science and Arts. Other organizations of a similar kind followed later, and one by one, especially of late years, the Classical Club, the Political Science Club, the Mathematical Club, and others at Yale have seized upon almost every field originally appropriated by the Academy, pursuing their studies with the ardor of youth, and the enthusiasm that is best kindled by daily intercourse between men engaged in the same pursuits, and acting under the lead of a trained scholar, eager to share with them the latest word of the best man on the subject in hand.

In 1836 President Day declined a re-election to the Presidency of the Academy, and that position passed into the hands of Professor Silliman.

In every association, whatever its form or purpose, the presiding officer holds a great power in the matter of shaping its general policy. It is the greater because it is largely undefined and, so to speak, unexpressed. He inspires resolutions which others offer;

leads the way to the consideration of this subject rather than that; appoints on committees those who reflect his own views. He is held by the public responsible for the success of the organization, and he must have an influence commensurate with his responsibility.

President Day's retirement loosened the connection between the Academy and the College, and none of his successors in the presidency of Yale have had any prominent official connection with the Academy. President Woolsey's studies ran in the direction of the classics and of political science and jurisprudence. From these the Academy had largely turned away since the institution of the American Journal of Science and Arts, and during his term of office as President of the University, the rise and growth of the Scientific School had brought it into a more vital connection with that than it had ever had with the college proper, or, as it now began to be called, the academic department.

Another change came over the Academy at the time when the last of its original founders were passing away. In the true and original sense it had from its early years been a convivial body. Nothing, after all, promotes freedom of intellectual intercourse, and the exchange of thought, so much as gathering to share a social meal. Such assemblies the Romans called *convivia* because, as Cicero says in one of his letters,† it is on occasions of this kind that life is most truly enjoyed.

From its early days it had been one of the unwritten laws and institutions of the Academy, that the member at whose house the monthly or bi-monthly meetings were held should provide some simple entertainment to succeed the regular business of the evening. At first the refection was confined to the fruit in season, or nuts and raisins. Later it assumed more the form of a supper, and while some of the members insisted that it did as much as anything else to hold the Academy together, there were others, among whom President (then Professor) Woolsey was prominent, who declared that it was a diversion from their proper work and ought to be abandoned.

In November, 1842, a committee was appointed to report on the expediency of such a change of practice, consisting of Rev. Dr. Murdock, and Professors Larned and Olmstead. A month

* To Lucius Papinius Paetus, Book XIII, Ep. IX.

later they reported that while the customary entertainment might be "an elegant and agreeable relaxation after the severer exercises of the meeting" and afforded a pleasant opportunity for social intercourse, yet, to quote their words, "that the indulgence of the sensual appetites never made a philosopher; that animal pleasures and indulgences are unbecoming and unsuitable in the conventions of scientific men for scientific purposes; that such festivities, late in the evening, are generally injurious to health; that the expense and trouble of preparing them are very considerable and unequally fall on only a part of the attending members; that these festivities are becoming more and more luxurious and expensive, and cannot easily be kept within moderate bounds; and lastly that they are a bad example to be exhibited in the vicinity of the college: they afford to dissipated students a plausible excuse for their midnight revels, and tend to paralyze the efforts of the college officers to restrain their pupils from debasing and expensive carousals."

The report was accepted, and so in Christmas week of 1842 the modest suppers of the Academy came to an end. Tradition says that President Woolsey never attended another meeting.

There is, in truth, a certain and altogether natural and right attraction to almost every man, now, as fully as in the days of Cicero, in the pleasures of the table, enjoyed in moderation and in congenial company. The Academy had thrown away what had been a real magnet, and its meetings as years went on became more formal, and not infrequently were without a quorum.

One may sometimes read between the leaves of history more than the page contains. I am inclined to think that President Woolsey's attack and Professor Larned's report came in part—though no doubt half unconsciously to themselves—from the fact that their wants in the direction of such social entertainments had been better met by an institution, now become a venerable one, founded in 1838 by eight gentlemen of the city, all, I believe, members of the Academy, and still known, by right of primogeniture, only by the name of "The Club."

This was a company of personal friends, by 1842 somewhat enlarged in numbers, who took tea, in the old New England fashion (what the housewives call a "high tea") at each other's houses in succession two or three times a month, and afterwards

listened to a paper or a talk on a given subject which was afterwards discussed by all in turn.

Of this President Woolsey, Professor Larned, Dr. Bacon, Professor Gibbs, Professor Twining, Henry White, Rev. Henry G. Ludlow and Dr. Henry A. Tomlinson were the original members, and in a smaller circle and with the freedom which greater intimacy gives, after what took the place of an ordinary meal could enjoy the pleasures of literary conversation.

The weakening of the Academy which followed the abandonment of the supper was soon manifested in another way.

A library of some value had been accumulated, partly by gift or exchange and partly by purchase, during its first half century. In 1847 the whole of it was sold to Yale College.

The Connecticut Historical Society of Hartford had been incorporated in 1825. Here was another organization formed to accomplish what had been originally one of the cherished objects of the Academy, and towards which its early members had made such important contribution. In 1847, at the same time when the library was disposed of, it was voted to deposit with this Society, as a loan, all the statistical accounts of Connecticut towns which remained in manuscript in its archives. These covered with more or less completeness, twenty-five towns.*

Subsequently, in 1859, when the Historical Society was about to publish a volume of its transactions, the Academy contributed a sixth of the entire cost.

The change of policy manifested by the steps taken in 1847 which I have mentioned was followed in 1848 by a vote to suspend the collection of the annual dues.

The Academy had thus in some measure settled its estate; but it was by no means dead. The meetings were still often of decided interest, and served at least to diffuse intelligence of what

* The list of the statistics thus turned over to the Connecticut Historical Society includes those for the following towns: Bethlehem, Bolton, Canterbury, Cheshire, Cornwall, Coventry, East Windsor, Farmington (Wintonbury parish), Franklin, Haddam, Goshen, Lebanon, Lisbon, Pomfret, Preston (North Society), Ridgefield, Stratford, Tolland, Union, Wallingford, Washington, Watertown, Willington, Windham, Winchester. Certain statistics as to New London remain in the archives of the Academy.

was going on in the scientific world.* In 1856 a movement was made toward resuming greater activity, by the introduction of a resolution "that literature as well as science and every subject tending to the advancement of knowledge or the promotion of human happiness comes within the scope and original plan of this Association," and further that papers suitable for publication should thereafter be published as from the Transactions of the Academy, either in the American Journal of Science or in the volume form, and that collection of the annual dues should be resumed.

A discussion, however, resulted in laying these propositions on the table. They were evidently somewhat antagonistic to the policy which had been adopted by the American Journal of Science, which naturally preferred to ignore the original sources from which so many of its articles were derived. In 1861, however, a vote was passed to request the editors of the Journal to give credit to the Academy for all papers which had formed a part of its transactions

A year later the Academy obtained what it had long needed, and the more imperatively, since the discontinuance of its evening suppers, a regular and fixed place of meeting. This was due to the kindness of Mr. Sheffield, one of its members, who is gratefully remembered as the founder of the Sheffield Sciéntific School.

Its last gathering at the house of a member was on November 19, 1862, at that of Tutor Lebeus C. Chapin, on the corner of Church and Wall streets, and it has met ever since at Sheffield Hall. In modelling that building, a few years later, Mr. Sheffield constructed the handsome library room in the third story with special reference to the wants of the Academy, and in conformity with his wishes, the Governing Board of the School in 1866 offered it as a place where our meetings could be permanently held. The offer was received with due thanks, but the Academy did not commit itself to an acceptance in terms. Had it done so, it would have been less wise and far seeing than those who laid its first foundations. The charter prepared by President Stiles and Mr. Devotion, in 1783, contemplated a building which the Acad-

* Those of its members most interested in philological studies had, under the lead of Dr. Murdock, procured a charter from the State in 1844 for their incorporation as the "Philological Society." Special Laws of Conn. IV, 1199.

emy should own, itself, and make a place, not only for its meetings, but for collections which might be of public value. Such a building may yet be its final home. Let us hope that when our successors celebrate its next centennial, it may be in an unborrowed hall, that shall perpetuate the name of some friend of learning and stand as his stately gift to science and the arts, as cultivated by the people of Connecticut.

In December, 1863, at the instance of Professor Gilman, now President of John Hopkins University, the Academy voted to recommence the publication of its transactions, but to aim especially at printing such papers as "on account of their length, their technical or special character, or their local interest, would be inappropriate to the American Journal of Science;" particularly disclaiming any desire to interfere with "the field which the Journal occupies with so much credit to the country and the College."

Collection of the annual dues of the Academy had been resumed, and with the aid of some special subscriptions to the publication fund, the first part of the first volume of the current series of our Transactions was carried through the press in 1865. In 1867 a further contribution of nearly $400 was received from the treasury of the "Yale Natural History Society," which had become practically defunct, to be devoted to the publication of papers on the branches of science which that Society had been formed to promote. In 1871 the second part of the volume appeared, and since then parts of volumes have been issued every few years, the tenth volume being now half through the press.

The general character of their contents is such as was indicated by the vote of the Academy in 1863. There is little in them of a popular character; but it may fairly be said that there has been much to interest and to inform the scientific reader. An occasional contribution will be found by students of philology, and one pertains to the general history of letters and the drama, but the subjects considered have generally been such as relate to Natural History, Physiology or Mathematics, and the papers mainly of the kind that are originally submitted by title, and are known only to the committee on publication before they appear in print.

While this is true of them, in the shape in which they appear in our Transactions, it is, however, no less true that in many instances the subject considered has been less formally presented

by the author at the meetings of the Academy, and the main results or conclusions thus communicated and discussed.

Our first published volume bore, as has been said, the name of Memoirs of the Academy. In planning for the second volume, half a century later, it was thought best to entitle it as the Transactions of the Academy. The question then arose whether it should be numbered as volume two, or volume one, and in view of this change of name, as well as of the great lapse of time since the earlier publication, it was concluded to make it the commencement of an independent series.

The exchange list of the Academy in 1810 was limited for the United States to the Massachusetts Historical Society; the American Academy of Arts and Sciences; the New York Agricultural Society; the New York Historical Society, and the American Philosophical Society.

Six copies of Part 1 of Volume I were also put in the hands of Dr. Noah Webster, to be transmitted by him to such foreign societies or libraries as he might think proper to select. At present our Transactions are exchanged for those of nearly a hundred learned societies in this country, and of more than twice as many in foreign countries.*

A valuable library has thus been accumulated, which is deposited for convenience, and under an arrangement which contemplates its remaining there permanently, in the library of Yale University, the head of which is also the librarian of the Academy.

The Academy now assembles monthly in the Faculty room on the first floor of Sheffield Hall, its last meeting being its seven hundred and eighty-sixth.

Its ordinary course of business does not differ materially from that which I have described as pursued half a century ago. Some topic previously announced is presented, either by a written paper, or an oral explanation, and opportunity is then given for a general discussion.

In this way, independently of what has been accomplished by its publications, the Academy has been of substantial service for a hundred years to the College and to the city, particularly, but often to the State and to the country, as well.

* About 225.

To some of the results of its labors I have already sufficiently adverted. I must add that too high a value can hardly be set on the Statistical Account of New Haven by President Dwight, as a study of an American town in the formative period of American government. It was republished, a few years ago, by the city authorities in its year book. A census of New Haven was also taken by a committee of the Academy early in the century, the results of which are on file in our archives, and well merit future publication The collection of statistics from all the towns in the State would probably have been achieved, had President Dwight lived ten years longer, and what was accomplished will be of the greatest importance whenever a history of Connecticut is written that deals, from the standpoint of the sociologist, with the character of her people and her institutions.

In 1836, when the two hundredth anniversary of the founding of New Haven was approaching, the Academy voted to appoint one of its members to prepare a historical address for the occasion, and took an active part in providing for its proper celebration. The address by Professor Kingsley, which was its main feature, was a careful and masterly production, and the Academy also procured, partly at its own expense, the striking of a set of medals to commemorate the day.

In 1873, the necessity of a better map of the State than any yet produced was made the subject of discussion at several of our meetings. The result was a memorial from the Academy to the General Assembly for a new topographic survey, and a public agitation of the question, out of which came the very excellent typographical atlas of Connecticut, published in 1893 by the collaboration of the United States Geological Survey and a Commission appointed by the State, of which the chairman was the present President of the Academy.

Provision was made by the Academy in 1799 for keeping at its expense a meteorological register, and the results contained in its archives, when combined with some records of an earlier and others of a later date, made by other observers at New Haven, constitute a history of the weather which is nearly complete from 1779 to the present hour.*

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* See the Yale Book, I, 385.

The stimulating effect of the discussions at the ordinary meetings of the Academy on the life of the community one is liable to underestimate. Here, one after another, each of the great discoveries of modern science, of the great advances in modern thought, has been presented by those competent to explain its character and bearings, and made familiar to a company of intelligent men, who in turn were sure to diffuse the information so received through a wider circle.

Thus, the stethoscope was exhibited and its utility demonstrated before the Academy by Dr. Charles Hooker in 1829, when it was still unknown to many of his profession, and distrusted by many more.

So of the discoveries and conclusions of Professor Marsh in the domain of palaeontology, several were informally communicated to the Academy before they had become the property of the world. In the field of philology, the origin and growth of language, early discussed, as we have seen, by President Dwight, was taken up, forty years ago, with a profounder scholarship, by Professor Whitney, and the positions stated here which he afterwards advanced in his printed works. It would be easy to refer to others, many of whom are still of us, who have in such ways contributed to make the ordinary meetings of the Academy a source of influence and power.

Its functions, however, have become, as the years go on, divided by sharper and sharper lines. Its unpublished transactions bear little relation to its published transactions. It may not unfairly be said that it prints nothing that has been read before it, and nothing that could be read before it. Our transactions include, as has been stated, much, the germ or antecedents of which have been the subject of an informal talk or brief paper at one of our meetings. But much of the matter is so elaborated and expressed in terms so technical as hardly to be intelligible to any one without the aid of plates and figures, and not to be intelligible to most of the author's associates in the Academy, at all. He is speaking to a different audience. The mathematician sends his message to scholars in his line,—to two or three in this foreign university, and two or three in that. The naturalist, in like manner, may interest one man in Vienna, another in Paris, another in Oxford. Neither of these writers, perhaps, could understand, or would care

to understand, the paper of the other. Each has made a contribution to the stock of human knowledge, and the Academy, without committing itself to the conclusions of any of its members, is glad to serve as a vehicle of transmission, by which such as it may deem of sufficient importance may be communicated to the scholars of the world.

The estimation in which the publications of the Academy are held by those to whom they are thus especially addressed may be shown from a single though certainly a conspicuous instance.

The three papers contributed by Professor J. Willard Gibbs to the second and third volumes of our Transactions, on Thermodynamics, and fresh modes of expression which Chemistry can borrow from Mathematics, have been universally recognized as containing practical suggestions of the first importance, as well as statements of certain laws never before distinctly formulated, as to the properties and inter-relations of heterogeneous substances. One of those (the law of phases) is now commonly known by chemists as Gibbs' law. These articles were translated into German by Professor Ostwald of the University of Leipsic, in 1892, and a French version of one of them, (that in regard to the equilibrium of heterogeneous substances), by Professor Chatelier of the College of France, has appeared this year at Paris. In the preface to this book, Professor Chatelier declares that the symbolic representations of chemical substances or compositions proposed by Professor Gibbs in the second volume of our Transactions have already proved of inestimable service to science by opening a way to the study of subjects so complex that it would have been absolutely impossible to reach any intelligible result without the aid thus afforded of what spoke to the senses and the imagination. A new branch of chemistry, he says, has thus been created "*dont l'importance, tous les jours croissante, devient aujourd'hui comparable à celle de la chimie pondérale créée par Lavoisier.*" *

I need not comment on the comparison thus suggested between the recent advance in chemical science flowing from the use of Professor Gibbs' methods of investigation, and the great stride taken in human knowledge when the "phlogiston" theory of Stahl was replaced by the proposition of Lavoisier that nothing is lost

* Équilibre des Systèmes Chimiques, Paris, 1899, vi.

in combustion, the weight of the products being equal to the weight of the constituents.

As we look back on the century which closes to-day, we cannot but see that the Connecticut Academy of 1799 was Yale College in another form.

In one sense it was a higher form, for it was a reaching forward to a broador field of acquirements and achievements than any college could lay open. It was a movement towards bringing to New Haven the life of a University,—the first movement; for the College had done nothing beside College work, save in the single line of theology.

Most of the original members of the Academy were graduates of Yale, and, if we except Dr. Webster, the leaders among them were actively connected with its faculty or board of government.

From such a body, formed in the eighteenth century, nothing was to be expected in the line of technical or abstract research.

For that the mind even of their great chief, President Dwight, was unfitted. He had large executive ability, and remarkable powers of close observation and forcible statement. But he was no scholar, as we now count scholarship.

The same thing may be said of his colleague Silliman. He had the art of teaching others what he knew himself. He was active in gathering facts upon which later science might build theories. But he was one of those from whose followers some soon must come to outstrip him.

It was not indeed until the second half of this first century of our existence that a generation of professed scholars existed in the United States. The material of our college faculties before that time was taken from the church, the bar, or the medical profession.* There were no doctors of philosophy. Dr. Shepard and Dr. Percival, who made, as has been said, the geological survey of Connecticut, were doctors of medicine. We are apt to forget how short was the entire list of college presidents and professors in the United States at the close of the eighteenth century. Instead of the thousands whom we can count to-day, they hardly

* Much of the teaching was done, as it still is in our professional schools, by men whose life was mainly devoted to other pursuits, to which their connection with the college was merely an incident. See Life of Francis Wayland, I, 210.

numbered fifty in all. It was the day of small things in American letters.

Our first volume of memoirs was such a collection as might now be made (but would not now be made) by the collaboration of a dozen intelligent men of liberal education, none of whom had made any department of human knowledge a special study, except so far as it might afford him a means of professional livelihood. I say would not now be made, for the world is quick to recognize the worth of specialization in scholarship, and to demand that what a learned academy shall publish be such as only learning and original research can produce.

The history of the Academy up to 1840 was sketched by Edward C. Herrick in the American Quarterly Register for August of that year. A later article in the Yale Book,* by Professor Loomis, brought it down to 1877. Its first century is now auspiciously closed, and its story is before you.

It is a record perhaps of no great achievements. It may have published no dazzling discoveries. Its influences have been often indirect, and their source perhaps unknown. But in one way or another, changing its course from time to time to meet the new conditions it had to face, as best it could, it has kept steadily to its work, with no break of activity, and hopes that it has done no dishonor to its position as the third in age of the literary societies of the United States.

It has failed in the original aim, indicated by its name, of serving to promote and develop the cultivation of the arts and sciences in the State of Connecticut in particular. Instead of becoming a real State organization, it has assumed the character of a local one. An association formed between men who live at a distance from each other may be able to gather many of them together at an annual meeting, or on some special occasion when topics of interest are to be discussed by those whose opinions are worth hearing.* Such is the case with our State Medical and Bar Associations, and those of the clergy of the various denominations. But if meetings are to be held monthly, and always at the same place, they will soon inevitably become meetings of those who reside there, and the proceedings will take a local color.

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* I. 329.

To this may be attributed in part the failure to complete the Statistical Account of the towns of Connecticut. Comparatively few, outside of New Haven, would interest themselves actively in a work directed and controlled by a handful of New Haven men.

On the other hand, the Academy has been a source for the diffusion of knowledge throughout all our States, and, we may say, throughout all the world. It has been, more than anything else, the perpetual springhead of the American Journal of Science, and its Memoirs and Transactions have preserved statistics, recorded observations and developed theories, that have been of service wherever science is cultivated and arts pursued.

It has not fulfilled all of its founders' hopes. But it may have done better. If it has narrowed its field in one direction, it has widened it in another.

It does not end the century as it began it. If it did, it would be unworthy of its name. It has changed with the times. New modes of action, new premises of reasoning, new rules of science, have become the property of the world. To these the Academy has sought to conform, and as it stands before the door of the Twentieth Century, and awaits its opening, it may claim to enter as one of the rightful heirs of possessions and possibilities to which it has itself made no unimportant contributions.

Child of the eighteenth century, trained at the school of the nineteenth, the Academy now steps forward to a third age, still in the spirit that belongs to perpetual youth. That can be claimed by the corporation formed for the promotion of knowledge, alone of all human things. Perpetuity comes to it as the gift of the State: youth as its birthright; for human knowledge is yet in its infancy, and what we have already accumulated will be seen by each future generation in a different light, bringing to them a new meaning, and asking from them new conclusions.

The business corporation, the ecclesiastical corporation, the corporation to support this or that particular school of professional practice, may find, as centuries go by, not only its methods but its objects antiquated and outworn. It is the corporation formed to promote all knowledge, to seek truth wherever it may be found, to expose error wherever it may be detected, that endures.

SCIENTIFIC THOUGHT IN THE NINETEENTH CENTURY.

It is an interesting fact that the life of our Association is almost coextensive with that nineteenth century of Christian civilization which is now drawing to a close. In intellectual, as in physical phenomena, we are tempted to overestimate the magnitude of near objects and to underestimate that of distant ones; but science and art tend to advance with accelerated velocity, and we are undoubtedly right in ranking the achievements of our age in science and its applications as far greater than those of any previous century.

When our predecessors assembled a hundred years ago to organize this Academy, they could avail themselves of no other means of transportation than those which were in use before the time of Homer. If they were required to traverse distances over land too great for convenient walking, they were carried or drawn by horses. If they had occasion to cross bodies of water, they used oars or sails We have been brought to our destination to-day by the forces of steam and electricity.

The harnessing of these mighty forces for man's use has transformed not only the modes of transportation, but also the processes of production of all kinds of commodities. It has wrought a revolution in the whole industrial system. The day of the small workshop is gone. The day of the great factory is come. Every phase of human life is affected by those arts which have arisen from the applications of science. Comforts and luxuries which a hundred years ago were beyond the reach of the most wealthy, are now available for the use of even the poor. Aniline dyes give to fabrics used for clothing or decoration colors beside which those of the rainbow are pale neutral tints. Sanitary science arrests the massacre of the innocents, and increases the average duration of human life. Anæsthetics and antiseptics take away from surgery its pain and its peril.

But, though our Association is an Academy of Arts and Sciences, it has, at least in its later life, devoted itself chiefly to the cultivation of pure science, leaving to other organizations the

development of the applications of science. Fitly, then, our thoughts to-day dwell, not upon the vast progress of the useful arts, but upon the progress of pure science. Not the economic and the industrial, but the intellectual history of our century claims our attention.

I do not propose, in the few moments allotted to me this afternoon, to give an inventory of the important scientific discoveries of the nineteenth century. The time would not suffice therefor, even were my knowledge of the various sciences sufficiently encyclopædic to justify me in the attempt. I wish rather to call your attention to a single broad, general aspect of the intellectual history of our age. I wish to remind you in how large a degree those general ideas which make the distinction between the unscientific and the scientific view of nature have been the work of the nineteenth century.

The first of these ideas is the extension of the universe in space. The unscientific mind looks upon the celestial bodies as mere appendages to the earth, relatively of small size, and at no very great distance. The scientific mind beholds the stellar universe stretching away, beyond measured distances whose numerical expression transcends all power of imagination, into immeasurable immensities.

The second of these ideas is the extension of the universe in time. To the unscientific mind, the universe has no history. Since it began to exist, it has existed substantially in its present condition. Among Christian peoples, until the belief was corrected by science, the Hebrew tradition of a creative week six thousand years ago was generally accepted as historic fact. If, on the other hand, unscientific minds, not possessed of any supposed revelation in regard to the date of the world's origin, thought of the universe as eternal, that eternity was still conceived as an eternity of unhistoric monotony. The scientific mind sees in the present condition of the universe the monuments of a long history of progress.

The third of these ideas is the unity of the universe. To the unscientific mind the universe is a chaos. To the scientific mind it becomes a cosmos. To the unscientific mind, the processes of nature seem to be the result of forces mutually independent and often discordant. Polytheism in religion is the natural counter-

part of the unscientific view of the universe. To the scientific mind, the boundless complexity of the universe is dominated by a supreme unity. One system of law, intelligible, formulable, pervades the universe, through all its measureless extension in space and time. The student of science may be theist or pantheist, atheist or agnostic; polytheist he can never be.

What, then, let us ask ourselves, has been the contribution of our century to the development of these three ideas, which characterize the scientific view of nature:—the spatial extension of the universe, the historic extension of the universe, and the unity of the universe.

The development of the idea of the extension of the universe in space belongs mainly to earlier times than ours. The Greek geometers acquired approximately correct notions of the size of the earth and the distance of the moon. The Copernican astronomy in the sixteenth century shifted the center of the solar system from the earth to the sun, and placed in truer perspective our view of the celestial spheres. But, though astronomy, the oldest of the sisterhood of the sciences, attained a somewhat mature development centuries ago, it has in our own century thrown new light upon the subject of the vastness of the universe. The discovery of Neptune has greatly increased the area of the solar system; the measurement of the parallax of a few of the brightest and presumably the nearest of the stars has rendered far more definite our knowledge of the magnitude of the stellar universe; and telescopes of higher magnifying power than had been used before have resolved many clusters of small and distant stars.

If the development of the idea of the spatial extension of the universe belongs mainly to an earlier period, the idea of its historic extension belongs mainly to our century. It is true, indeed, that Pythagoras and others of the ancient philosophers did not fail to recognize indications of change in the surface of the earth. And, in the beginning of the Renaissance, we find Leonardo da Vinci and others insisting that the fossils discovered in excavations in the stratified rocks were proof of the former existence of a sea teeming with marine life, where cultivated lands and populous cities had taken its place. Hutton's "Theory of the Earth," which in an important sense marks the beginning of modern geological theorizing, appeared in the Edinburgh *Philosophical*

Transactions in 1788, but was not published as a separate work till seven years later. Not till 1815 was published William Smith's Geological Map of England, the first example of systematic stratigraphic work extended over any large area of country. To the beginning of our century belong also the classical and epoch-making researches of Cuvier upon the fossil fauna of the Paris basin. By far the larger part, therefore, of the development of geologic science, with its far-reaching revelations of continental emergence and submergence, mountain growth and decay, and evolution and extinction of successive faunas and floras, belongs to the nineteenth century. Far on into our century extended the conflict with theological conservatism, in which the elder Silliman, James L. Kingsley, and others of the early members of our Academy bore an honorable part, and which ended in the recognition, by the general public as well as by the select circle of scientific students, of an antiquity of the earth far transcending the limits allowed by venerable tradition.

To our century also belongs chiefly the development in astronomy of the idea of the history of the solar system. It is, indeed, true that, in the conception of the nebular hypothesis, Laplace, whose "Théorie de la Monde" was published in 1796, was preceded by Kant and Swedenborg; but the credit of a discovery belongs not so much to the first conception of an idea as to its development into a thoroughly scientific theory. Our century, moreover, has added to those evidences of the nebular theory which Laplace derived from the analogies of movement in the solar system, the evidence furnished by the spectroscope, which finds in the nebulæ matter in some such condition as that from which the solar system is supposed to have been evolved.

But by far the most important contribution of this century to the intellectual life of man is the share which it has had in developing the idea of the unity of nature. The greatest step prior to this century in the development of that idea (and probably the most important single discovery in the whole history of science) was Newton's discovery of universal gravitation two hundred years ago; but the investigations of our century have revealed, with a fullness not dreamed of before, a threefold unity in nature —a unity of substance, a unity of force, and a unity of process.

Spectrum analysis has taught us somewhat of the chemical constitution, not only of the sun, but also of the distant stars and

nebulæ; and has thus revealed a substantial identity of chemical constitution throughout the universe. Profoundly interesting, from this point of view, is the recent discovery, in uraninite and some other minerals, of the element helium, previously known only by its line in the spectrum of the sun. Profoundly interesting will be, if confirmed by further researches, the still more recent alleged discovery of terrestrial coronium.

The doctrine of the conservation of energy formulates a unity of force in all physical processes. In this case, as in others, prophetic glimpses of the truth came to gifted minds in earlier times. Lord Bacon declared heat to be a species of motion. And Huyghens, in the seventeenth century, distinctly formulated the theory of light as an undulation, though the mighty influence of Newton maintained the emission theory in general acceptance for a century and a half.

When Lavoisier exploded the phlogiston theory, and laid the foundation of modern chemical philosophy, it was seen that, in every chemical change, there is a complete equation of matter. But there was in the phlogiston theory a distorted representation of a truth which the chemical theory of Lavoisier and his successors ignored. They could give no account of the light and heat and electricity so generally associated with chemical transformations. These "imponderable agents," as they were called, believed to be material, yet so tenuous as to be destitute of weight, haunted like ghosts the workshop of the artisan and the laboratory of the scientist, wonderfully important in their effects, but utterly unintelligible in their nature. It was almost exactly at the beginning of our century that the researches of Rumford discovered the first words of the spell by which these ghosts were destined to be laid. When Rumford declared, in his interpretation of his experiments, "Anything which any insulated body or system of bodies can continue to furnish without limitation, cannot possibly be a material substance," the fate of the supposed imponderable body, caloric, was sealed; but it was not till near the middle of our century that Joule completed the work of Rumford by the determination of the mechanical equivalent of heat. About the same time, Foucault's measurement of the velocity of light in air and in water afforded conclusive proof of the undulatory theory of light. In these great discoveries was laid the

strong foundation for the magnificent generalization of the conservation of energy—a generalization which the sagacious intuition of Mayer and Carpenter and Le Conte at once extended beyond the realm of inorganic nature to the more subtile processes of vegetable and animal life. In this connection, I may be permitted to refer to the work of some of my colleagues, with the Atwater-Rosa calorimeter, which has given more complete experimental proof than had previously been given of the conservation of energy in the human body.

But by far the greatest of the intellectual achievements of our age has been the development of the idea of the unity of process pervading the whole history of nature. The word which sums up in itself the expression of the most characteristic and fruitful intellectual life of our age is the word evolution. The latter half of our century has been so dominated by that idea in all its thinking, that it may well be named the Age of Evolution. We may give as the date of the beginning of the new epoch the year 1858; and the Wittenberg theses of the intellectual reformation of our time were the twin papers of Darwin and Wallace, wherein was promulgated the theory of natural selection.

And yet, of course, the idea of evolution was not new, when these papers were presented to the Linnæan Society. Consciously or unconsciously, the aim of science at all times must have been to bring events that seemed isolated into a continuous development. To exclude the idea of evolution from any class of phenomena is to exclude that class of phenomena from the realm of science. In the former half of our century, evolutionary conceptions of the history of inorganic nature had become pretty well established. The nebular hypothesis was obviously a theory of planetary evolution. The Lyellian geology, which took the place of the catastrophism of the last century, was the conception of evolution applied to the physical history of the earth.

Nor had there been wanting anticipations of evolution within the realm of biology. The author of that sublime Hebrew psalm of creation, preserved to us as the first chapter of Genesis, was in his way a good deal of an evolutionist. "Let the earth bring forth,"—"let the waters bring forth,"—are words that point to a process of growth rather than to a process of manufacture in the origination of living beings. In crude and vague forms, the idea

of evolution was held by some of the Greek philosophers. Just at the beginning of our century Lamarck developed the idea of evolution into something like a scientific theory.

Yet it is no less true that the epoch of evolution in human thought began with Darwin. Manifold suggestions there were of genetic relationships between different organisms, whether organic forms were studied by the systematist or the embryologist, the geographer or the paleontologist; but each and all found the path to any credible theory of organic evolution blocked by the stubborn fact that variations in species appeared everywhere to be limited in degree, and to oscillate about a central average type, instead of becoming cumulative from generation to generation. In the Darwinian principle of natural selection, for the first time, was suggested a force, whose existence in nature could not be doubted, and whose tendency, conservative in stable environment, progressive in changing environment, would account at once for the permanence of species through long ages, and for epochs of relatively rapid change. However Darwin's work may be discredited by the exaggerations of Weismannism, however it may be minified by Neo-Lamarckians, it is the theory of natural selection which has so nearly removed the barrier in the path of evolution, impassable before, as to lead, first the scientific world, and later the world of thought in general, to a substantially unanimous belief in the derivative origin of species. Certain it is that no discovery since Newton's discovery of universal gravitation has produced so profound an effect upon the intellectual life of mankind. The tombs of Newton and Darwin lie close together in England's Valhalla, and together their names must stand as the two great epoch-making names in the history of science.

Darwin's discovery relates primarily to the origin of species by descent with modification from preëxisting species. It throws no direct light upon the question of the origin of life. But analogy is a guide that we may reasonably follow in our thinking, provided only we bear in mind that she is a treacherous guide and sometimes leads astray. Conclusions that rest only on analogy must be held tentatively and not dogmatically. Yet it would be an unreasonable excess of caution that would refuse to recognize the direction in which analogy points. When we trace a continuous evolution from the nebula to the dawn of life, and again a con-

tinuous evolution from the dawn of life to the varied flora and fauna of to-day, crowned with glory by the appearance of man himself, we can hardly fail to accept the suggestion that the transition from the lifeless to the living was itself a process of evolution. Though the supposed instances of spontaneous generation all resolve themselves into errors of experimentation, though the power of chemical synthesis, in spite of the vast progress it has made, stops far short of the complexity of protoplasm, though we must confess ourselves unable to imagine any hypothesis for the origin of that complex apparatus which the microscope is revealing to us in the infinitesimal laboratory of the cell, are we not compelled to believe that the law of continuity has not been broken, and that at least a reasonable hypothesis as to the method of natural transition from the lifeless to the living may yet be within reach of human discovery?

Still further. Are we content to believe that evolution began with the nebula? Are we satisfied to assume our chemical atoms as an ultimate and inexplicable fact? Herschel and Maxwell, indeed, have reasoned, from the supposed absolute likeness of atoms of any particular element, that they bear "the stamp of a manufactured article," and must therefore be supposed to have been specially created at some definite epoch of beginning. But, when we are speaking of things of which we know so little as we know of atoms, there is logically a boundless difference between saying that we know no difference between the atoms of hydrogen and saying that we know there is no difference. Is it not legitimate for us to recognize here again the direction in which analogy points, and to ask whether those fundamental units of physical nature, the atoms themselves, may not be products of evolution? Thus analogy suggests to us the question, whether there is any beginning of the series of evolutionary changes which we see stretching backward into the remote past; whether the nebulæ from which systems have been evolved were not themselves evolved; whether existing forms of matter were not evolved from other forms that we know not; whether creative Power and creative Intelligence have not been eternally immanent in an eternal universe. I cannot help thinking that theology may fitly welcome such a suggestion, as relieving it from the incongruous notion of a benevolent Deity spending an eternity in soli-

tude and idleness. The contemplation of his own attributes might seem a fitting employment for a Hindoo Brahm. It hardly fits the character of the Heavenly Father, of whom we are told that he "worketh hitherto."

In the last suggestion I have ventured outside the realm of science. But most men are not so constituted that they can carry their scientific and their philosophical and religious beliefs in compartments separated by thought-proof bulkheads. Scientific and philosophic and religious thought, in the individual and in the race, must act and react upon each other. It was, therefore, inevitable, that our century of scientific progress should disturb the religious beliefs of men. When conceptions of the cosmos, with which religious beliefs had been associated, were rudely shattered, it was inevitable that those religious beliefs themselves should seem to be imperilled. And so, in the early years of the century, it was said, "If the world is more than six thousand years old, the Bible is a fraud, and the Christian religion a dream." And later, it was said, "If physical and vital forces are correlated with each other, there is no soul, no distinction of right and wrong, and no immortality." And again it was said, "If species originate by evolution, and not by special creation, there is no God." So it had been said centuries before, "If the earth revolves around the sun, Christian faith must be abandoned as a superstition." But in the nineteenth century, as in the sixteenth, the scientific conclusions won their way to universal acceptance, and Christian faith survived. It showed a plasticity which enabled it to adapt itself to the changing environment. The magically inerrant Bible may be abandoned, and leave intact the faith of the church in a divine revelation. The correlation of forces acting in the human cerebrum with those of inorganic nature may be freely admitted; and yet we may hold that there are in the universe other forms of causation than physical energy, and that the inexpugnable belief of moral responsibility is more valid than the strongest induction. The "carpenter God" of the older natural theology may vanish from a universe which we have come to regard as a growth and not a building; but there remains the immanent Intelligence

> "Whose dwelling is the light of setting suns,
> And the round ocean, and the living air,
> And the blue sky, and in the mind of man;"—

the God in whom "we live and move and have our being."

The church has learned wisdom. The persecution of Galileo is not likely to be repeated, nor even the milder forms of persecution which assailed the geologists at the beginning, and the evolutionists in the middle, of our century. And science, too, has learned something. In all its wealth of discovery, it recognizes more clearly than ever before the fathomless abysses of the unknown and unknowable. It stands with unsandaled feet in the presence of mysteries that transcend human thought. Religion never so tolerant. Science never so reverent. Nearer than ever before seems the time when all souls that are loyal to truth and goodness shall find fellowship in freedom of faith and in service of love.

WILLIAM NORTH RICE.

THE DEBT OF THIS CENTURY TO LEARNED SOCIETIES.

Address by Professor WILLIAM H. BREWER, President of the Academy.

In meeting together to rejoice over the completion of a hundred years' work, it is fitting that we should consider what the character of that work has been and what its relations are to the century's progress.

In the few minutes allotted me, any detailed history of the origin of learned societies will be impossible. I wish, therefore, to speak more particularly of the role they have played during the one hundred years of this Academy's existence, and I think it will be found that, in this period, they have been, directly or indirectly, a most potent factor of progress in material advancement and in intellectual culture. Their influence has probably been even greater than that of the universities, in that they have dealt with adult men rather than with youth; for it is from men in mature life that the impulse comes which demands and promotes progress.

When the Connecticut Academy was founded, the terms "learned," "learned societies," and "intellectual culture," were broad and comprehensive in theory, but in active use they were curiously restricted. There were then but three "learned" professions,—law, medicine, and theology. The universities recognized a fourth comprehensive department,—philosophy. But since that date, and chiefly during the last thirty or forty years, the world has acknowledged many other professions as learned. In my own college days, I can not remember of ever hearing the term "professional" engineer, or "professional" chemist, except as applied to the teachers of engineering or of chemistry in technical schools, colleges, or universities. I had never then heard the term "professional engineer" applied to a person whose vocation was that of planning or of carrying out engineering works, nor to the chemist employed in the manufacture of commercial products.

All this now is changed, and the public understanding as to what "learning" signifies is very different. The civil engineer, designing and building great structures; the mechanical engineer, employing abstruse mathematics in economizing the energies used in steam engines, electric motors, or water wheels; the chemist, conducting great metallurgical works or manufacturing commercial products: each is recognized as belonging to a learned profession as truly as is the village lawyer, the parish clergyman, or the country doctor. So, too, the societies of engineers, chemical and other similar associations, are recognized as learned societies as truly as those which are more especially devoted to history, literature, pure science, medicine, or philosophy.

But no line of separation can be drawn between those societies honored with the term "learned," organized for the promotion of intellectual culture, and those designed purely for material or economic objects. Nor does the precise name indicate the intellectual status. Under various designations,—academies, societies, associations, and clubs, they range through every grade.

Very few of the existing academies and learned societies of the world were founded before 1750. But between the middle and the end of the eighteenth century, the great social and industrial revolutions first allowed and then promoted the establishment of many such organizations. Some of these, although relating more particularly to the industries, may in a sense be classed as learned, since the promotion of science for its practical use in the arts of life can not be separated from its promotion for purely scientific investigation or mental culture.

In this country but two "learned societies" had been founded prior to the establishment of the Connecticut Academy, and when the last century closed these were too young to have had much influence. Before our Revolutionary War, the American Philosophical Society of Philadelphia was the only strictly learned society as then understood, but there were also a few local medical associations.

Zoology and botany may be said to have been established by Linnæus about 1750 or a little later. Geology and chemistry had their true beginning during the last quarter of the same century. There were, of course, a science and a literature of botany long before, as there was likewise a so-called science of

chemistry and geology, but these were not founded on natural laws in the sense in which these sciences are now understood.

The practical application of the natural sciences to the arts and industries began with the development of the sciences themselves, and the two went on together, so closely associated that they were never independent of each other. They were parallel and correlated. This was more especially felt as chemistry and geology progressed. Their applications were so important and varied, and the possible effects so far-reaching, that learned men began to take means to disseminate the knowledge gained and to make it available. While investigators in pure science thus labored directly to increase the sum of human knowledge, and indirectly to increase man's intellectual pleasure by contemplation of the phenomena of nature, the practical applications of science furnished the proper stimulus.

Hence, the dawning of the light of modern science inaugurated a new era in the arts and industries. Agriculture and manufactures form the foundation of civilization. Cultured nations subsist on the products of the soil; and without manufactures, particularly of the metals, there can be no considerable wealth. As arts, these industries had been developing from pre-historic times, but as mere arts unaided by science, they furnished little hope for advance in higher development. As populations became denser, and the soil was longer tilled, new problems arose which art alone could not solve. There was and could be no science of metallurgy or of agriculture until there was a science of chemistry; and other industrial arts had scarcely advanced for thousands of years.

As soon as chemistry and geology began to assume the dignity of exact sciences, their aid was, therefore, immediately invoked in various arts and industries. But it was agriculture that made the strongest demands for assistance. Consequently, before the close of the last century, agricultural societies were established in nearly every country of Europe, and in America as well. "*The Philadelphia Society for the Promotion of Agriculture*" was instituted in February, 1785, less than two years after the achievement of our national independence. A similar society was formed in Charleston, South Carolina, in August of the same year; another in New York, in February, 1791, one in

Massachusetts, in March, 1792; and in Connecticut, in August, 1794. The New York society was organized "for the promotion of Agriculture, Arts and Manufactures;" the others specified agriculture only. "*The Connecticut Society for the Promotion of Agriculture*" was founded three and a half years before this Academy, and for many years some of its leading members were the same men who were prominent in the Academy.

The material interest involved was so vast, that a few states attempted to carry on agricultural schools. Finally, in 1862, the United States Congress appropriated land for the establishment of schools of science in every state in the Union; and the organization of Agricultural Experiment Stations soon followed. That all this might have been accomplished in time, without the stimulus of "societies," is possible. It is probable, however, that, but for them, there would have been no such rapid spread of instruction in science and its applications.

We must bear in mind that in 1799 there was very little, if indeed any, natural science taught in the colleges and universities of this country. One or two professors of chemistry were appointed in the very last years of the last century, and a few more in the first decade of this. Instruction in geology came in somewhat later, but for forty years or more after the foundation of this Academy, in only half a dozen of the numerous colleges of the country was anything more than the merest rudiments of chemistry and geology taught, and nothing whatever of natural history except a little botany, which was also taught in some of the medical schools.

During this period, a somewhat better condition of things existed in the universities of Europe. There was a continuous appeal from the various industries to the colleges and higher institutions of learning for more instruction in the natural sciences. But from no other source was this appeal more persistent and at the same time more effective than from the many societies which had been formed in all these countries for the promotion and encouragement of science.

Polytechnic schools were started after a fashion about the beginning of this century, but it was not until later that they came into existence as schools of science, to be pursued for its application to the liberal arts. In a number of cases, these

schools were actually established by local societies, by extending their work from that of interesting adults to the teaching of youth also. To-day, polytechnic institutions are for "higher education," and scientific investigation goes on in them as truly and as zealously as in the universities.

Among the sciences, chemistry and geology have been much alike in their influence in turning the current of popular attention toward science. They are cultivated for their practical applications more than the other natural sciences, and this has brought them into closer touch with the masses of intelligent men in the industries.

So long as chemistry was pursued as a mere art, it was associated with astrology and magic. While its devotees sought the Philosopher's Stone or the Elixir of Life, the outside public looked on with awe and superstition. When the art of alchemy developed into the science of chemistry, there was a sudden burst of light. The mysterious chemical transformations, which before had awakened in the outside world only an awe resulting in superstition, now inspired a new interest, and awe was transmuted into scientific curiosity, a desire to learn what the laws were which controlled the wonderful phenomena.

Geology is so extensively an applied science that it receives more government aid than any other science. Geological surveys are established in every civilized country, because of industrial necessities. The first geological surveys, systematically made, of which I have any knowledge, were instigated and carried on under the direction of the early societies; and later, when states took up the work, it was often the case that this action was first stimulated by the local societies. This Academy initiated an early geological survey of Connecticut. The facts which these surveys brought out called into existence special geological societies. The field geologists had to meet in order to unify and systematize their publications, as well as for mutual instruction and encouragement. The meetings of the American Geologists led to the organization of the wider and more general *American Association for the Advancement of Science.* This in turn has reacted on the general public, and diffused the knowledge gained by special investigators. The great truths thus spread have given intellectual pleasure to thousands who do not study geology for its practical applications.

The oldest geographical society dates back to 1740, and there were but few, if any, more at the close of that century. In this century they have multiplied enormously. Some of them are general, but the great majority are either local or special in their objects. They have done much to extend and disseminate geographical knowledge, but vastly more in stimulating and cultivating a taste for the enjoyment of natural scenery. They followed rather than led the development of the societies for the promotion of geology and natural history, but have had much to do with fostering a love for these sciences in later times. Their most obvious effect on intellectual culture is the part they have played in cultivating a taste for nature, and in changing public sentiment in respect to the appreciation of natural scenery. The contemplation of the beauties of mountains or the sublimity of nature in her grander aspects formed an inconspicuous part of the intellectual pleasures of mankind until lately. Neither in the literature of sacred or profane writers of antiquity, nor in the literature of the middle ages, is there evidence of any such sentiment as pervades the poetry and literature of the century now closing. No one climbed mountains for the sake of enjoying the grandeur of the view, nor visited them to enjoy their beauties. Mountains were held in awe and fear; they were the abode of dragons and demons; they must sometimes be crossed because of necessity, but were never visited for the sake of pleasurable contemplation until scientists led the way. Before the last quarter of the last century, there are two or three records of persons visiting the Alps to see the wonderful glaciers; but to the world at large the Alps were dreary, desolate, awful. There are many allusions in literature to this fact.

As soon as the various branches of natural history began to develop as sciences, mountainous countries became most interesting fields for investigation, and began to be visited by scientific men, particularly those interested in geology, botany, and zoology. In 1760, that eminent scientist and lover of nature, de Saussure of Geneva, visited the valley of Chamounix, and the next year he advertised throughout the region that he would liberally reward any one who could discover a practical way to reach the top of the "Great White Mountain." Further, should the attempts be unsuccessful he would pay for the time lost in seeking a way.

Men crossed the mountains for business, and there were hardy guides well acquainted with the country, but they visited passes, not peaks. And not till more than a quarter of a century later did the guide Balmat succeed in finding a path to the top. The very next year (1787), de Saussure made his famous ascent, the first in history when any high mountain was climbed for scientific observation. There was a second ascent the following year, but no other till 1802. During the twenty-five years after de Saussure, there were less than half a dozen ascents; but no attempts whatever, that I am aware of, were made to climb any other high peaks. About 1840 were begun by Agassiz and Forbes those researches on glaciers, classic in the annals of science.

When these pioneers had successfully frightened away the demons and devils that had so long guarded the mountain mysteries and veiled their beauties, the general public, learned and unlearned people alike, began to find pleasure in the contemplation of the wild and the grand, and this sentiment now finds abundant expression in poetry, song, literature, and art. The exploration of mountains for scientific investigation has resulted in enormous gain to mankind in intellectual and æsthetic pleasure. There is to-day scarcely a mountain range in any country of our civilization but has a society or club of devotees organized for its study. As learned societies, they have greatly promoted our geographical knowledge; incidentally they have contributed in large measure to the amount of pleasure to be derived from travel and from the better appreciation of the beauties of nature.

Switzerland, which had been shunned for two thousand years because of its dreary mountains, has now, because of those same mountains, become the playground of Europe, and mountain climbing, about which so many tales of terror were formerly told, has now become a pastime and a sport. Railways carry the strong and the weak alike to peaks high in the clouds.

The publications of learned societies, under various names and in various ways, furnish by far the most comprehensive literature of science, philosophy, history, and art, that we have. For a time, this was almost the only way of publishing to the world new discoveries. To-day it is as pervasive as it is extensive, and as yet no substitute has been found for this means of publishing and dis-

seminating the details by which results have been obtained, even if the bare results might be made available through the periodical press or other channels. These publications are an important part of every public library, but by reason of their enormous extent no library can be complete in them. It is only when we attempt to investigate their number in any branch of science that we can appreciate the great influence such associations must have had in diffusing learning and information among the mass of the people and in making it available for their industries, their comfort and their intellectual pleasure.

Many of the learned societies maintain libraries and museums, and in some cases these libraries furnish almost the only considerable scientific literature accessible to the community, while the museum gives them further knowledge of other regions of the earth than their own.

Finally, learned societies practice and cultivate the brotherhood of mankind as do no other organizations. Science knows no nation nor country; it is bounded neither by oceans nor continents; its home can not be located by latitude or longitude; it knows no race nor people; it swears special allegiance to no form of government; it is bound by no creed; it claims no one language. A new fact observed, a new law demonstrated, immediately becomes public property. No matter in what continent or country it originates, or to what nation or creed or race the discoverer belongs, or in what language the new truth is first announced; the learned societies discuss it, and pass upon it, they aid in disseminating it, their publications give it a measure of authority, and through the various channels for the diffusion of knowledge it is sure in time to become the common property of mankind.

The function of these organizations will of course be modified in the new century upon which we are approaching, but it is safe to say that they will contribute as greatly to its progress as they have to that of the century now closing. Societies of one kind and another are to-day so numerous, they embrace such a wide range of objects, and there is gathered into them so large a proportion of the active men of all the countries of our modern civilization, that they have come to be the leading and perhaps the most important factor in shaping and directing human activities, both material and intellectual.

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I.—Observations on the Digestion of Proteids with Papaïn. By Lafayette B. Mendel and Frank P. Underhill.

[From the Sheffield Laboratory of Physiological Chemistry, Yale University.]

In his recent book on "The Soluble Ferments and Fermentation," J. R. Green writes: "It is uncertain whether pepsin is represented in the vegetable kingdom. All the proteolytic enzymes which have been fully investigated have been found capable of carrying the hydrolysis beyond the stage of peptone. The work of the earlier observers did not include a careful examination of the products of the decomposition, and hence for the present it remains uncertain whether or no some of the ferments belong to the peptic category."[1] In another connection the same author says: "On a review of all these vegetable proteolytic enzymes it will be seen that our knowledge is not at present sufficiently definite for us to say whether we have to do with one or many. Some of them may be peptic only, though it seems probable that they are all tryptic. Those which have been at all exhaustively examined undoubtedly carry the proteolysis to the stage of crystalline amides. We do not yet know, again, whether there is one enzyme only, varying somewhat in its features according to the conditions of its secretion, or whether the different plants discussed yield different varieties of trypsin. Bromelin and papain certainly show very little difference in their behaviour, and one is tempted to pronounce them identical. For the present, however, it is perhaps advisable to leave this question undecided."[2]

The proteolytic enzyme obtained from the fruit and juices of the melon-tree *Carica papaya* and ordinarily termed papaïn (papayotin),[3] has usually been regarded as closely related in its action to the trypsin of the pancreas.[4] There are, however, very few reliable observations on record which permit one to draw a definite conclusion regarding the class to which the enzyme may properly be assigned. The

[1] J. R. Green: The Soluble Ferments and Fermentation, 1899, p. 195.

[2] Green: loc. cit., p. 219.

[3] Moncorvo employed the term "Caricin." (Jahresbericht für Thierchemie, 1880, x, p. 294.) Other names, such as "Caroid," "Papoid," are applied to commercial preparations of the enzyme.

[4] Neumeister: Lehrbuch der physiologischen Chemie, 1897, pp. 141, 237. Moore: Schaefer's Text-book of Physiology, 1898, i, p. 403. Oppenheimer: Die Fermente und ihre Wirkungen, 1900, p. 185. (The references to the literature on papaïn and its action are here given.)

earlier investigators were content to note that the extracts of various parts of the plant, and preparations made from them, are able to dissolve proteids like fibrin in the presence of antiseptics, e. g. thymol and hydrocyanic acid. It had long been known that parts of the *Carica papaya* possess a vigorous action in softening meat and were used by the natives of tropical countries, when Wurtz[1] began his more careful studies of the proteolytic enzyme present in the plant. He gave to it the name papaïn, and ascertained that it dissolved fibrin, raw meat, coagulated egg-white and gluten; milk was clotted by it and the precipitated casein subsequently dissolved. He further found that a slightly purified enzyme mixture dissolved fibrin in acid, neutral and alkaline media. Regarding the products formed, Wurtz merely states in one case that 0.1 gram of his papaïn dissolved one hundred grams of moist fibrin in a neutral medium in the presence of HCN in thirty-six hours; from the products formed a small quantity of a crystalline substance having the appearance of leucin was isolated.[2] No mention is made of tyrosin. Because of the readiness with which it acts in neutral fluids, Wurtz concluded that papaïn is closely related to trypsin.

Somewhat later Martin[3] undertook a study of papaïn. He used a commercial preparation in most of his experiments, while in a few cases the dry juice of the unripe fruit was employed. The results of the digestive action of the commercial papaïn on fibrin and egg-albumin solution were reported. Prussic acid was used to prevent putrefactive changes. A quantitative study of this enzyme preparation indicated that it was active in the highest degree in neutral and alkaline solutions (one-fourth per cent. Na_2CO_3); in solutions of higher alkalinity (one-half or one per cent. Na_2CO_3), the action, though well marked, was not so great. Acid prevented the action of the papaïn, though in weakly acid solutions (0.05 per cent. HCl) some degree of digestion may have taken place. Martin also investigated the products formed during the papaïn-digestion of fibrin in neutral and alkaline media. He observed the early formation of a "globulin-like" substance intermediate between the native proteid and the derived alkali-proteid usually formed in proteolysis. We shall have occasion to refer to this body later. It is not precipitated like alkali-proteid when the digestive fluids are neutralized, but separates out

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[1] Wurtz and Bouchut: Comptes rendus de l'Academie des Sciences, 1879, lxxxix, p. 425. Wurtz: ibid., 1880, xc, p. 1379; 1880, xci, p. 787.

[2] Wurtz: Comptes rendus de l'Academie des Sciences, 1880, xc, p. 1379.

[3] Martin: Journal of Physiology, 1884, v, p. 213; 1885, vi, p. 336.

abundantly when these neutral fluids are heated. Its occurrence is too characteristic and the quantities formed are too large to be ascribed to traces of unprecipitated alkali-proteid. Peptones (in the older sense) were obtained by concentrating the filtrates from the globulin-like body and precipitating with a large excess of alcohol a substance which gave the biuret reaction and was readily diffusible. From the alcoholic solution, crystals of leucin were obtained. Martin experienced more difficulty, however, in showing the presence of tyrosin. No crystals could be obtained; but when the alcoholic peptone-filtrate was dried, an extract could be prepared from it with absolute alcohol. This solution gave Millon's reaction and led Martin to conclude the presence of tyrosin. In his own words "we have, then, in papaïn a proteolytic ferment acting almost exactly like trypsin: similar in the proneness of decomposition in solution, in its erosion of coagulated proteid: in the formation of an 'intermediate' body from the proteid; and the formation of a perfect peptone, and of leucin and tyrosin."[1] Later Martin obtained impure crystals of tyrosin and leucin from the dried papaw juice, and also apparently identified them in small quantity among the products of the self-digestion of this material. The crude way in which the material at his disposal was prepared by no means excludes the possibility of previous decomposition through the agency of bacteria and the formation of bacterial enzymes.[2] This might, at least, reasonably be assumed of a "yellow brown powder of sickly smell" obtained by drying, chiefly in the East Indies, the juice of the unripe fruit in the open air and under glass. Furthermore the quantity of leucin and tyrosin—if such they were—obtained in the digestions with large quantities of proteid, was extremely small when compared with the typical results of tryptic proteolysis; and Martin himself has been far more cautious in drawing any final conclusion than have those who have subsequently quoted his investigations. For he says: "It is evident moreover that too general a deduction cannot at present be drawn as to the nature of the proteolytic change, as to whether the agent acts like animal pepsin or like trypsin."[3] In studying the literature of papaïn proteolysis we have been surprised to find upon what scanty and meagre data some of the current statements on the subject are based; and we have dwelt particularly upon these widely quoted observations of Martin to illustrate this point.

[1] Martin: loc. cit., 1884, v, p. 230.

[2] Some commercial preparations have been reported to contain spores and dead forms of bacilli. (Dowdeswell: Practitioner, 1883, xxx, May.)

[3] Martin: Journal of Physiology, 1885, vi, p. 360.

In 1892, Chittenden[1] published the results of an extensive study of the digestive action of "Papoid," a therapeutic agent prepared from the various parts of the papaw plant, *Carica papaya*. The enzyme-like character of the preparation was clearly shown by the readiness with which it dissolved proteids like fresh and boiled fibrin, raw and cooked beef proteids and coagulated egg-white in neutral, alkaline and acid media, even in the presence of various antiseptic agents.

While the attention of this investigator was directed particularly to the conditions under which the proteolysis proceeds best, he incidentally made several observations with reference to the products formed. With coagulated egg-albumin, a peculiar albumose-like body, a deuteroalbumose, a fairly large amount of peptone and some leucin and tyrosin were isolated. With raw blood-fibrin and cooked beef-proteids similar results were obtained.[2] Particularly conspicuous was a soluble albumose formed in the fibrin digestions. It was completely precipitable from a neutral solution by heat and partook of the general character of hetereoralbumose, being insoluble in water but completely insoluble in salt solutions as well as in dilute acids and alkalies. This substance recalls the "globulin-like" body described by Martin. While calling attention to the points of resemblance between the action of papoid and trypsin, Chittenden points out that the latter is ordinarily associated with an alkaline secretion, and as a proteolytic agent acts to advantage only in alkaline fluids. On the other hand, the action of papoid in neutral solutions is increased by the addition of a very small amount of hydrochloric acid. Wurtz[3] has also stated that the liquid juice of the papaw is neutral in reaction. Chittenden therefore merely concludes "that the power possessed by papoid of dissolving various forms of proteid matter is dependent upon an ordinary digestive action akin to, or identical with, that of digestive ferments in general, whether animal or vegetable.

In a subsequent paper from this laboratory[4] it was demonstrated that not only are true albumoses (in Kühne's sense) formed by various commercial papaïn preparations acting in different media, but

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[1] Chittenden: Transactions of the Connecticut Academy of Arts and Sciences, 1892, ix, p. 298.

[2] We learn from Professor Chittenden that the quantities of leucin and tyrosin found by him were small at the most.

[3] Wurtz and Bouchut: Comptes rendus de l'Academie des Sciences, 1879, lxxxix, p. 425.

[4] Chittenden, Mendel and McDermott: American Journal of Physiology, 1898, i, p. 255. The references to the literature are given in this paper.

—contrary to the statements of several writers—peptones, *i. e.*, biuret-giving compounds not precipitable by ammonium sulphate or zinc sulphate, are formed in considerable amounts. The latter were separated from digestive mixtures and their physiological action was investigated. Previous to this Neumeister[1] only had directed attention to this point. His report is, however, very scanty, and the commercial preparation of "papayotin" which he used must have been rather inactive; for although it dissolved coagulated egg-white in an alkaline mixture, it failed to digest fresh fibrin or to act in acid or neutral solutions. He arrived at no definite conclusion regarding the nature of the enzyme.

The present investigation is the outcome of an attempt to isolate the end-products of the action of papaïn upon purified proteids. Relying upon such statements as have been introduced into the literature on this subject, we had expected to find a marked resemblance in character between the products formed by trypsin and those resulting from papaïn proteolysis. Our experiments, on the contrary, soon indicated that pronounced differences exist. From the data accumulated we feel justified in reporting some additional features regarding the action of the papaw enzyme. We have not been fortunate enough to secure specimens of the fruit itself for study; but the results obtained with four commercial preparations from different sources are fairly concordant and characteristic and give no occasion to suspect the extensive admixture of other enzymes. These preparations will be referred to below as Papaïn A, B, C, and D; they were bought under the names of "Papoid," "Caroid," "Papaïn (Lehn and Fink's)," and "Papaïn (Merck's)" respectively. Our observations will be considered under four chapters in the part following.

I. The Influence of the Reaction on the Proteolytic Action of Papaïn.

A survey of the literature on the action of papaïn shows that the observers have by no means been agreed regarding the conditions of reaction under which proteolysis proceeds favorably. Wurtz, the earliest careful investigator of this point, and Chittenden, who made the most exhaustive study (with "papoid"), both found the enzyme active in acid, alkaline and neutral media, as already indicated. Similar observations were made by Polak[2] with two papaïn prepara-

[1] Neumeister: Zeitschrift für Biologie, 1890, xxvi, p. 82.
[2] Polak: Jahresbericht für Thierchemie, 1882, xii, p. 254.

tions in the digestion of various proteids. While nearly all writers have found that weakly alkaline fluids favor the action of papaïn, there has been great diversity of experience regarding the influence of acid reaction.[1] Undoubtedly the conditions determining the character of the acid reaction, *i. e.*, the presence or absence of *free* mineral acid, are of decisive influence and have been overlooked in this connection, as frequently elsewhere, in discussions regarding enzyme activity.[2] Our own experiments confirm the results obtained by the three writers above named in showing pronounced proteolytic activity in digestive mixtures with various reactions.

Methods. The general course of these experiments has been to treat the proteid used with relatively concentrated solutions of the enzyme preparation under examination, enough sodium fluoride being dissolved in the mixture in every case to make the total strength of this antiseptic equivalent to at least one per cent. Previous trials had demonstrated that this salt does not interfere seriously with the action of papaïn.[3] The digestions were carried on in an oven at 37° C. In the series of quantitative trials reported below ten grams of moist coagulated egg-white, finely comminuted, were used. To this, 50 c.c. of 0.2 per cent. HCl were added for the acid digestions, 50 c.c. of 2 per cent. $HNaCO_3$ solution for the alkaline digestions, and 50 c.c. of water for the neutral media. Finally 1.5 grams of papaïn were digested with 125 c.c. of water and 50 c.c. of the filtrate were employed in each digestion. Each digestion mixture was thus made up as follows:

10 grams of moist proteid (2.025 grams of dry proteid),
100 c.c of fluid containing 1 gram NaF,

$$\text{papaïn and}\begin{cases}0.1 \text{ per cent. HCl, or}\\ 1\ 0 \quad \text{"} \quad HNaCO_3\text{, or}\\ \text{water}\end{cases}$$

Control trials were simultaneously carried out with boiled papaïn solutions, and lastly the solvent action of the fluids used was ascertained.[4] After allowing the digestive action to proceed at 37° C.

[1] For the literature references on this point see Oppenheimer: Die Fermente und ihre Wirkungen, 1900, p. 186, also Pickardt: Centralblatt für Physiologie, 1900, xiv, p. 351.

[2] *Cf.* Hanford: American Journal of Physiology. 1900, iv, p. 250.

[3] *Cf.* Chittenden, Mendel and McDermott: American Journal of Physiology, 1898, i, p. 259.

[4] The complete extent of digestive action is not always accurately represented in this way, since what is estimated as undigested residue may frequently be made up in part of transformation products, like antialbumid, resulting from the work of the enzyme.

with frequent agitation of the mixture for four hours, it was stopped by heating, and the undissolved residue filtered upon dried and weighed ash-free papers, then thoroughly washed with hot water and dried to constant weight at 105° C. From the figures thus obtained the percentage of proteid dissolved was calculated. The results are tabulated below.

PAPAÏN DIGESTION OF COAGULATED EGG-ALBUMIN.

(The figures indicate the percentages of proteid dissolved.)

Medium.	Papaïn A unboiled	Papaïn A boiled	Papaïn B. unboiled	Papaïn B. boiled	Papaïn D. unboiled	Papaïn D. boiled	Controls without Papaïn Solution.
0.1 per cent HCl,	8.7	2.3	14.5	2.9	40.6	5.4	6.0
1.0 " $HNaCO_3$,	24.0	8.7	54.0	1.2	66.7	2.1	4.2
water,	16.6	0.8	41.7	4.0	72.7	6.1	2.4

In evidence of the statement already made regarding the activity of papaïn preparations in both alkaline and acid media, we might add many additional data. In numerous qualitative tests with various papaïn preparations acting on fibrin, casein, boiled and unboiled muscle tissue, in the presence of 2 per cent. NaF and in media acid with 0.1 per cent. HCl, or alkaline with 1.0 per cent. $HNaCO_3$ or 0.5 per cent. Na_2CO_3, or in approximately neutral fluids, vigorous solvent action was always observed. In considering the relatively weak digestive action noted above in the case of the acid mixtures, it should be borne in mind that the strength of acid here recorded is rather large[1] and by a selection of more appropriate conditions the solvent power could doubtless have been considerably increased.

II. Are Leucin, Tyrosin and Tryptophan formed by Papaïn?

When trypsin acts upon ordinary proteids, leucin, tyrosin and tryptophan (proteinochromogen) are speedily formed in considerable quantities. These compounds do not arise in appreciable amounts in pepsin-HCl digestion under ordinary circumstances, although some recent experimental work leads to the conclusion that relatively simple bodies (including leucin) may occur in prolonged proteolysis with pepsin. Thus Lawrow[2] found large quantities of leucin formed by the self-digestion of 12 kilos of pigs' stomachs with 35

[1] *Cf.* Chittenden: Transactions of the Connecticut Academy of Arts and Sciences, 1892, ix, p. 307.

[2] Lawrow: Zeitschrift für physiologische Chemie, 1899, xxvi, p. 513.

litres of 0.6 per cent. HCl at 40°–45° C. for two months. Experiments of this type will scarcely appeal to one as offering reliable evidence regarding the work of the enzyme pepsin, especially as no control experiments to show the influence of such large excesses of free hydrochloric acid are presented. How vigorously dilute acids alone may act on proteids has been shown by Fr. Goldschmidt.[1] More important, however, are experiments like those of Pfaundler.[2] This investigator showed that while in prolonged pepsin-HCl digestion there arise products which no longer give the biuret reaction, leucin and tyrosin cannot be found ready formed. Tryptophan, in particular, has always been regarded as a typical product of tryptic enzymes, although Malfatti[3] has recently observed that it may be formed by extracts of the stomach He gives no conclusive proof, however, that the action is due to the enzyme pepsin. Tyrosin has not been found among the products of pepsin-proteolysis.

Bertrand[4] and others have shown that extracts of *Russula delica* and other species of fungi contain an oxidizing enzyme, which they named tyrosinase, and which brings about a black coloration when added to solutions containing tyrosin. The reaction is one of oxidation and may be observed with many genera. Harlay has subsequently asserted that this reaction is a delicate test for the presence of tyrosin and enables one to distinguish between the products of peptic and tryptic digestion. With peptic digestion mixtures the extracts of *Russula* yield a red, then green color; tryptic products turn red, then black. Applying this test to the products of papaïn digestion, Harlay[6] has observed a resemblance in reaction to that obtained with the peptic digestion products. Although these observations, published during the progress of our experiments, were made with extracts of a different member of the papaw family, viz., *Carica hastifolia*, they lend additional evidence to the results which we have obtained with the closely related species.

[1] Goldschmidt: Ueber die Wirkung von Sauren auf Eiweisstoffe. Inaugural-Dissertation, 1898, Strassburg.

[2] Pfaundler: Zeitschrift für physiologische Chemie, 1900, xxx, p. 99.

[3] Malfatti: Zeitschrift für physiologische Chemie, 1900, xxxi, p. 48.

[4] Bertrand: Bulletin de la société chimique, 1896 (3), xv, p. 793. Bourquelot: Bulletin de la société mycologique de France, 1897, xiii, p. 65. *Cf.* also Green: The Soluble Ferments and Fermentations, 1899, pp. 299, 300.

[5] Harlay: Journal de pharmacie, 1899 [vi] 5, p. 225.

[6] Harlay: Abstract in Journal of the Chemical Society, 1900, Part I, July, p. 419.

We have searched for leucin, tyrosin and tryptophan among the products of papaïn digestion under a variety of conditions. In a very large number of experiments we have uniformly failed to detect them. They are therefore, in our opinion, not normal products of the proteolytic action of papaïn. Enzyme preparations from four different manufacturers were tested in solutions of differing reactions and on the following proteids: casein, fibrin, coagulated egg-albumin, muscle tissue (boiled and unboiled). Only in one series of experiments, viz., those with unboiled muscle tissue, did the products already referred to regularly appear. These cases will be considered in detail below.

Methods. The digestions were carried out at 35°–38°C. in the presence of two per cent. sodium fluoride, or thymol, to avoid bacterial decomposition. The reaction of the digestive mixtures varied as described on page 6. At the end of varying periods of time they were filtered and neutralized, when necessary; the fluids were then heated on the water bath, and after the removal of the characteristic albumose-like body which usually separates out, they were concentrated to a small volume and set aside in a cool place to allow bodies like leucin and tyrosin to crystallize out. Finally the residues were extracted with warm alcohol to remove some of these latter compounds and eliminate the greater part of the soluble proteids. The alcoholic extracts were in turn concentrated, allowed to stand, and carefully examined under the microscope for crystals of leucin and tyrosin. Trytophan was searched for by the bromine-water test both in the original concentrated neutralized solution and in the final alcoholic extracts.

The results of over sixty trials made with the four papaïn preparations (more particularly with papaïn A, B and D) and with the proteids mentioned, were entirely negative so far as the appearance or detection of leucin, tyrosin or tryptophan was concerned. The observations were so concordant in this respect, that it is scarcely necessary to enumerate the variations in time of digestion, the reaction of the digestive media, the quantity of enzyme used and other details. Comparisons with control trials always indicated a vigorous digestion in every case. In some instances the digestion was allowed to continue at 35°C. for over a month without altering the results noted. Only with fresh muscle tissue were these tryptic end-products obtained. When hashed muscle (lean beefsteak), washed free from blood with water, was digested with papaïn in the presence of two per cent. sodium fluoride, the tryptophan reaction was repeatedly

obtained in the acid digestions; and frequently typical leucin crystals, less often characteristic tyrosin crystals, could be detected with the microscope. There was no difference in the three papaïn preparations in this respect. The suspicion that the meat thus prepared long after the death of the animal might be contaminated with bacterial enzymes, led to the use of dog's and rabbit's muscle removed from the freshly killed animal immediately after perfusion of the blood-vessels with isotonic sodium chloride solution to wash out the blood completely. Precisely similar results were obtained with such material in the acid and neutral media. Finally trials were made with muscle tissue previously heated in boiling water. With the boiled muscle no leucin, tyrosin or tryptophan was ever obtained. These facts seem to indicate the existence of an enzyme in the muscle tissue which may assist in the proteolysis accomplished by papaïn on the fresh tissue and may carry the action to a stage where relatively simple products are formed. The self-digestion (autolysis) of muscle after exclusion of bacteria by the use of chloroform-water, was observed long ago by Salkowski.[1] He failed to find leucin and tyrosin among the products. More recently Jacoby[2] obtained large quantities of leucin, tyrosin and also tryptophan in the self-digestion of the liver. These observations indicate an explanation for the exceptional results obtained with fresh muscle tissue in our papaïn digestions, by referring to the muscle itself the active agent in the production of tryptophan, etc., in these cases—a conclusion which is supported by the uniformly negative results obtained with the heated tissue.

III. The Nature of some Products of Papaïn Proteolysis.

While the experiments just outlined indicate the marked difference between trypsin-and papaïn-proteolysis so far as the end-products formed under ordinary conditions are concerned, a closer study of the primary products has shown them to resemble in many respects the bodies obtained under similar conditions in pepsin-hydrochloric acid digestion. Our investigation in this direction has been confined to the proteid casein, since this is readily obtained in large quantities in a state of considerable purity. The products formed from casein by pepsin-hydrochloric acid have been investigated by Chittenden[3] and

[1] Salkowski: Archiv für Physiologie, 1890, p. 554; Zeitschrift für klinische Medicin, 1890, xvii, Supplementband, p. 77.

[2] Jacoby: Zeitschrift für physiologische Chemie, 1900, xxx, p. 162.

[3] Chittenden: Studies from the laboratory of physiological chemistry, Yale University, 1887, ii, p. 156; 1889, iii, p. 66.

his pupils, and more recently by Fr. Alexander.[1] The latter employed the method of fractional precipitation introduced by E. P. Pick[2] for the albumoses. We have followed their scheme of analysis quite closely, and refer to the papers of the writers mentioned for the details of the method. The separation of the individual caseoses was made in the neutralized and somewhat concentrated digestion filtrates, after removal of the characteristic albumose-like substance which has already been referred to as precipitating when heat is applied. Instead of reproducing our protocols at length, we give an outline of one of several experiments with casein and then add a brief resumé of the main results ascertained from all the trials.

Experiment A. In this experiment $1\frac{1}{2}$ kilos of moist casein obtained from skimmed milk and purified by re-precipitating three times were treated with $2\frac{1}{2}$ liters of 0.25 per cent Na_2CO_3, 4 grams of papaïn A and strong alcoholic thymol solution. The mixture was kept at 38° C. for 11 days. During this interval portions had repeatedly been withdrawn and examined for leucin, tyrosin and tryptophan (as described on page 9) with negative results Therefore 4 grams of papaïn were again added. After digesting for 7 days longer, during which time samples had again been withdrawn and examined for leucin, etc., with negative outcome, the material was filtered and neutralized with acetic acid, whereupon a very slight precipitate was obtained. The filtrates were then concentrated as already indicated, until they contained about ten per cent of dissolved substance On treatment of the carefully neutralized fluid with saturated ammonium sulphate solution, Fraction I, which began to be precipitated when a content of 2.6 c.c. of saturated ammonium sulphate solution in a total volume of 10 c.c. was reached, was completely separated when 6 c c of the sulphate solution were present. In a large portion of digestion material this fraction was then precipitated by mixing ten volumes of the digestive solution with nine volumes of ammonium sulphate solution (following Alexander),[3] and after standing, this fraction was filtered off completely. In this filtrate the lower limit of precipitation was found to be 5.1 c.c., and the upper limit at 6.7 c.c. of ammonium sulphate solution. Fraction II. was then separated from a larger quantity of the original material by adding one volume of it to three volumes of saturated ammonium sulphate solution. For this filtrate obtained therefrom, lower and upper precipitation limits of 7 8 c.c., and about 9.5 c.c. of ammonium sulphate solution respectively were ascertained. Fraction III. was therefore removed by saturating the remainder of the original digestion material with ammonium sulphate crystals and filtering after some hours. When the salt-saturated fluid thus obtained was further treated with $\frac{1}{10}n$ sulphuric acid (saturated with ammonium sulphate) a precipitate, Fraction IV., separated. It was relatively large in quantity and was removed by adding one-half volume of the salt-saturated acid to the entire fluid. The filtrate still gave a strong biuret reaction, indicating the presence of pep-

[1] Alexander: Zeitschrift für physiologische Chemie, 1898, xxv, p. 411.
[2] Pick: Zeitschrift für physiologische Chemie, 1897, xxiv, p. 246.
[3] Alexander: Zeitschrift für physiologische Chemie, 1898, xxv, p. 418

tones. The latter were removed by precipitation with an equal volume of Lugol's solution saturated with ammonium sulphate. This peptone precipitate could always be divided into two fractions; one insoluble (V) and the other soluble (VI) in 95 per cent. alcohol. These portions both gave the biuret reaction.

Experiment B. This was carried out under precisely the same conditions as Experiment A, except that 2.3 liters of 0.02 per cent HCl were added instead of the alkali. A total of 8 grams of papain A was added, and the digestion stopped after 28 days. No leucin, tyrosin or tryptophan were found. The results of the fractional analysis are given below.

Experiment C. Alkaline digestion containing 300 grams of freshly precipitated casein, 1500 c.c. of 0.25 per cent. Na_2CO_3, 4 grams of papaïn B and thymol solution. Digestion at 38° C. for 26 days.

Experiment D. Acid digestion like Experiment C except that 1500 c c. of 0.02 per cent. HCl were added in place of the alkali.

Experiment E. Alkaline digestion like Experiment C, the enzyme used being papaïn C. Digestion at 38° C. for 26 days.

Experiment F. Acid digestion like Experiment D, with papaïn C. Digested at 38° C. for 26 days.

A summary of the results of the fractional precipitation of the digestion products according to the general plan outlined under Experiment A follows. The figures given indicate cubic centimetres of saturated sulphate solution in a total volume of ten cubic centimetres.

FRACTIONAL ANALYSIS OF THE PAPAIN DIGESTION.

Preparation Used.	Conditions of Experiment.	Limits of Fraction I	Limits of Fraction II	Limits of Fraction III	Character of Fraction IV.	Character of Fraction V.	Character of Fraction VI.
Papaïn A	A. alkaline	2.6—6.0	5.1—6.7	7.8—9.5	light	more than VI	light
	B. acid	2.6—5.8	5.1—6.9	7.6—9.5	heavy	" " "	"
Papaïn B	C. alkaline	2.4—?	5.8—?	7.8—9.5	"	" " "	"
	D. acid	2.2—?	5.5—?	8.0—9.5	light	" " "	"
Papaïn C	E. alkaline	2.6—?	5.5—?	7.8—9.5	very light	light.	more than V
	F. acid	2.4—?	5.8—?	8.0—9.5	heavy	more than VI	light
Pepsin[1]	Acid	2.6—4.4	5.2—7.2	8.2—9.5			

The results obtained with different enzyme preparations and under varying conditions show a fairly close agreement with one another and a resemblance to those already published by Alexander for the gastric digestion of casein. He concluded that at least four caseoses and two casein-peptones are formed in the pepsin-hydrochloric acid proteolysis of casein Our results indicate that similar products may arise through the action of papaïn, and they lend additional emphasis to the specific character of papaïn as an enzyme.

[1] Alexander: Zeitschrift für physiologische Chemie, 1898, xxv, p. 418.

IV. General Conclusions.

The observations recorded in this paper indicate that papaïn belongs to a class of enzymes which differs somewhat in type from the two proteolytic enzymes that have received most careful investigation in the past, viz., pepsin and trypsin. While the products of the papaïn digestion of proteids resemble quite closely those of pepsin so far as these have been examined in detail, the enzyme differs from ordinary animal pepsin in that it acts readily in both neutral and alkaline media. On the other hand, although papaïn is comparable with trypsin in exerting a solvent action in fluids of various reactions, the failure to form leucin, tyrosin and tryptophan in appreciable quantities—at least under conditions in which they are readily formed in large quantities by other tryptic enzymes—places it in a class of its own for the present.

The failure of papaïn to conform exactly with any of the standards set in the past for proteolytic enzymes need not surprise us. The more carefully such enzymes—especially those from vegetable sources—are being examined with reference to their activities, the more varied are found to be the manifestations which characterize and distinguish them. We may refer, for example, to bromelin, the proteolytic enzyme of the pineapple (*Ananassa sativa*), which has been studied very thoroughly by Chittenden[1] Bromelin readily forms leucin and tyrosin in large quantities in both acid and neutral media, besides the characteristic proteoses and peptones.[2] This recalls the proteolytic enzyme of the yeast, discovered by Salkowski and quite recently found by Hahn and Geret[4] in the yeast juice expressed by Buchner's method. It acts with intense vigor, giving rise readily to leucin and tyrosin; peptone is not obtained and albumoses occur only in traces; acid reaction is favorable, while alkalies retard digestion with it. The circumstance that the favorable reaction corresponds with the one best for pepsin, while the products formed resemble those resulting in trypsin proteolysis (the absence of peptones being unique), has led Hahn and Geret to classify this yeast enzyme by itself and to give it a new name: yeast endotrypsin.

[1] Chittenden: Journal of Physiology, 1893, xv, p. 249.

[2] In unpublished experiments by O. H. Schell, Ph.B. and one of us, tryptophan and other end-products were found in addition to those already described

[3] Salkowski: Zeitschrift für physiologische Chemie, 1889, xiii, p 527

[4] Hahn and Geret: Zeitschrift für Biologie, 1900, xl, p. 117.

Similarly the enzyme found by Green[1] in the germinating seeds of *Lupinus hirsutus* acts in acid media, forming leucin and tyrosin; but the primary products are also found. Related enzymes have been described by others. The proteolytic enzyme of the pitcher plant, *Nepenthes*, which Vines[2] has studied, seems to resemble pepsin most closely; for it acts only in acid fluids, forming large quantities of albumoses, small amounts of peptone and only traces of leucin, if any. Tyrosin has not been obtained In writing of various vegetable enzymes, Vines says: "It is a remarkable fact that, whatever may be the reaction of the medium in which they can work, all these enzymes are essentially tryptic in their mode of action; in fact it is not improbable that this may be a characteristic feature of all vegetable proteolytic enzymes whatsoever."[3] On the contrary, we believe that the actual experiments of Vines, as well as the work recorded in this paper, make it more probable that plants, like animals, produce various kinds of proteolytic enzymes.[4]

April, 1901

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[1] Green Philosophical Transactions of the Royal Society, London, 1887, B, clxxviii, p 39

[2] Vines Annals of Botany, 1897, xi, p 563, 1898, xii, p 546

[3] Vines loc cit, 1898, xii, p 555

[4] *Cf* Pfeffer Pflanzenphysiologie, 1897, i, p 511 512

II.—ADDITIONS TO THE FAUNA OF THE BERMUDAS FROM THE YALE EXPEDITION OF 1901, WITH NOTES ON OTHER SPECIES.

BY A. E. VERRILL.

THE following additions to the fauna of the Bermudas are due almost entirely to the large collections made in the spring of 1901, by Mr. A. H. Verrill, who was there from March 7th to May 9th, and the writer, who took part in the work from April 10th to May 9th. Dr. W. G. Van Name joined us during the latter part of the time, but he worked chiefly on the Tunicata, which are not included in this article.

About 75 species of insects and 25 species of spiders were also obtained. Many of these were not before known from Bermuda, but they will be treated in subsequent articles. The numerous Isopoda and Amphipoda, and most of the Annelida, also remain to be studied, as well as many of the smaller shells, among which there are probably many additions to the fauna. There are also some additional land shells, Myriapoda, earthworms, etc.

I have added notes on some of the rarer or less known species, of those previously recorded,* where such information seemed particularly desirable, for the benefit of future students.

That so many species of comparatively large and conspicuous marine animals could be added in a few weeks to the fauna of a locality, where so many previous collections have been made, may seem strange. This is due, however, partly to a very careful scrutiny of the hiding places of those forms that depend upon concealment for their safety, partly upon the fact that localities were visited where we did not collect in 1898, in which certain species seem to be localized, and perhaps, in some cases, upon the earlier season of the year (March), when some of the new forms came into shallow water to spawn.

The illustrations are mostly from colored drawings, made from life, by Mr. A. H. Verrill. Others are from photographs made by him, either from living or freshly killed specimens. It is unfortunate that the colored figures could not now be reproduced in colors by the Academy, for in these groups of soft-bodied animals the colors are often highly characteristic, as well as beautiful.

The marine invertebrate fauna of the Bermudas, now known, includes about 900 species. The known fishes are about 200.

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* Species previously recorded are in italic type. Those now first recorded (so far as known) are in black-face type.

CRUSTACEA.

DECAPODA.

Epialtus bituberculatus M. Edw (?) var **Bermudensis** Ver

PLATE I. FIGURE 1.

This form differs so decidedly from the several so called varieties of *E. bituberculatus* figured by A. Milne-Edwards (Crust. Reg. Mex., p. 137, pl xxvii) that it seems necessary to give it, at the least, a varietal name. Indeed, the differences are so great as to indicate a distinct species, but, unfortunately, we obtained only a single example. It resembles the *E. Braziliensis* Dana, considered a variety by A. M. Edw., more than *var. affinis* Stimp. From both it differs in having a much longer and differently shaped rostrum; in the more transverse front edge of the carapax and the much deeper emargination on the sides; the more prominent lateral tubercles; the much longer legs and chelipeds; and especially in the much longer and differently shaped chelæ.

The length of the rostrum to that of the rest of the carapax is as 1:1.62; the length of the carapax (without rostrum) to its breadth is as 1:1.30; the length of the chelæ is equal to that of the carapax to base of rostrum; the length of the chelæ to the breadth is as 3:1, their distal portion being decidedly the larger. Total length of carapax and rostrum, 15.7^{mm}; greatest breadth, 12.3^{mm}; length of rostrum, 12^{mm}; of chelæ, 10.3^{mm}.

The sides of the carapax are deeply concave in outline between the two tubercles; the anterior tubercles are much the larger, but the posterior are a little more prominent and more acutely angular, their anterior edge being incurved. The rostrum is rather long with the outlines in front of the eyes distinctly incurved, but the tip is obtusely rounded; there is a pair of distinct angular denticles in front of the eyes, back of which the outlines are nearly parallel. The front margins of the carapax are nearly transverse, sloping but little from the orbits to the antero-lateral tubercles, which are bluntly rounded.

The color in life was brownish purple, becoming greenish anteriorly and grayish on the legs; on the posterior part of the carapax there is a large, broad T-shaped spot of cream-color. Chelipeds yellowish brown, the claws whitish.

Flatts Inlet, cut out of a deep hole in a ledge, one specimen only, April, 1901 (A. H. V.).

The *E. bituberculatus* is recorded from Chili, Panama, Florida (var. *affinis*), Brazil, etc.

Pericera subparallela Stimp.

Pericera subparallela Stimpson, Ann. Lyc. Nat. Hist. N. York, vii, p 182 [54], 1860, (St. Thomas.) A. Milne-Edw., Crust. Reg. Mex., p 54, pl. xiii, figs. 3-3d. (Gaudaloupe.)

A single specimen of this species, from Bermuda, was in the collection of 1898. It has been determined by Miss M. J. Rathbun.

Platypodia spectabilis (Herbst).

Cancer lobatus Milne-Edw., Hist Nat Crust., i, p 375

Atergatis lobatus Stimpson, Ann Lyc Nat Hist N York, 1860, p. 74.

Lophactæa lobata A. Milne-Edwards, Nouv Arch Museum, Mem I, p. 249, pl xvi, fig. 3 ; Crust. Reg Mexico, p. 242. Rankin, Annals N. York Acad, xii, p 529

PLATE I. FIGURE 2

Several specimens of this beautiful species were obtained under stones and among bright colored sponges. In life its colors are very bright, but imitative of sponges, etc. The carapax is bright orange-red with particolored, irregular, broad streaks, blotches, and angular or rounded ocellated spots of various sizes. These generally have a small, bright yellow center, surrounded by a wide white band, which is edged with bright blue and surrounded by a thin black line. The arrangement of the spots and blotches is variable. Sometimes small, round, ocellated spots, with the several colors distinct, occur on the large light blotches, either singly or in lines or groups; others are scattered over the carapax. The chelipeds and legs are colored in the same way, but here the spots mostly take the form of half-bands, or angular patches at the joints. The tips of the claws are black. The larger patches of color are often unsymmetrically arranged on the carapax, which tends to obscure its outline and increases the imitative effect.

Cardiosoma Guanhumi Latr. Great Land Crab.

M.-Edw., Illust. ed. Cuvier, pl. xx, figs. 1-1i. S. I. Smith, these Trans., ii, p. 143, pl. v, fig. 3, 1870.

In addition to the locality for this large land crab on Cooper's Island, mentioned in my former paper (vol. x, p. 573), we this year found its large holes in considerable numbers near the shore at Hungry Bay, on the south side of the Main Island. As the holes are very deep and generally excavated among stones and the roots of trees, it is very difficult to dig them out. They are said to come out of their holes in the night, in summer. If so they might, perhaps, be captured by torchlight.

Cycloïs Bairdii Stimpson.

Cycloïs Bairdii Stimpson, Notes on N. Amer. Crust., II, Annals Lyc. Nat. Hist. New York, vol. vii, p. 237 [109], 1860, (Cape St. Lucas.)
M. J. Rathbun, Proc. U. S. Nat. Mus., xxi, p. 610, 1898; Bull. Univer. Iowa, 1898, p. 290, (Bahamas.)

PLATE II. FIGURES 1, 2.

In life the carapax is pale yellow or yellowish white with several rows of lemon-yellow spots and with rather numerous smaller spots of bright red or crimson, chiefly near the lateral margins and on the antero-lateral teeth. Chelipeds and legs brighter yellow, banded and spotted with bright red. The chelæ have a large crescent-shaped spot of red on the inner side at the joint, and the tips and dorsal spines are red; two spots of red on the carpus. Ambulatory legs brighter yellow, with three or four bands of red and purple at the joints and with marginal lines of purple; eye-stalks orange and yellow. Two living specimens of this species, about two inches broad, were taken by A. H. Verrill, in shallow water on a sandy bottom, near "Waterloo," Castle Harbor, April, 1901. The cast shells, some of them of larger size, were also found on the north side of Long Bird Island, opposite the sand flats, in May.

It was originally described from Cape St. Lucas, where it is abundant. Specimens from Panama (Capt. J. M. Dow) are in the Museum of Yale University. Miss M. J. Rathbun has recorded it from the West Indies. She considers our specimens identical (judging from the photographs).

Clibanarius Verrillii Rathbun.

Amer. Journ. Science, xi, p. 328, April, 1901.

PLATE VIII. FIGURE 2, 3.

A few small specimens that appear to belong to this species were taken this year, at Hungry Bay. The figure, here given, is from one of the original types.

Albunea oxycephala Miers.

PLATE VIII. FIGURE 1.

A large and perfect living specimen of this fine species was dug out of the sandy beach, between tides, near Hungry Bay, February, 1901, by Mr. T. G. Gosling, and presented to us. The photograph, here reproduced, was from this specimen. No other example was found. It is probably rare at this season of the year, but like *Hippa*, it may be more common in summer. Its color, in life, was

yellowish white, or about the color of the shell-sand in which it lives.

Tozeuma Carolinensis Kingsley.

Tozeuma Carolinensis Kingsley, Proc. Acad. Nat. Sci., Philad., 1878, pp. 90, 328, 1879, p. 413, pl. xiv, fig. 8; Amer. Naturalist, xxxiii, p. 715, fig. 8, 1899.

A small, slender and delicate shrimp. Rostrum long, flat, and narrow, its edge nearly straight above, without teeth, above or below but with a fine spinule at the base, back of the eyes; at tip, which is subacute, there are fine spinules, and hair-like ones below.

Chelipeds much shorter than the other legs, with a short swollen claw and a short, round carpus. Second pereipods much longer and more slender, with a small chela and a short carpus.

Other legs long and slender, not chelate; eye-stalks are short, swollen at base.

Dredged in three fathoms, on a soft weedy bottom, in Castle Harbor, May, 1901.

Thor Floridanus Kingsley.

Thor Floridanus Kingsley, Proc Acad Nat. Sci. Philad., 1878, p. 95; op. cit., 1879, p. 421, pl. xiv, fig. 6, Amer. Naturalist, xxxiii, p. 718, fig. 20, 1899.

A small, stout-bodied, smooth shrimp, with large conspicuous black eyes, on stout stalks, and a short rostrum, not quite reaching the tips of the eyes, and having four or five acute denticles on the sloping upper edge; but none below. The anterior feet are stouter and shorter than the next pair, wlth small, rather short chelæ. Those of the second pair are decidedly longer and filiform, with minute chelæ and a very slender, 5-jointed carpus. The other legs are of about the same length, but stouter and subequal.

The body and legs are translucent whitish with minute specks of orange-red; eye-stalks, antennal scales, and outer maxillipeds tinged with orange in formalin (this color was not noted in the living specimens). Eggs rather large, not very numerous, orange in formalin.

Dredged in "The Reach," in two to three fathoms, shell-sand and mud, May 5th, 1901. Two females with eggs.

Gnathophyllum Americanum Guerin.

Gnathophyllum Americanum Guérin, in La Sagra's Hist. I. Cuba, vol. vii, p. xx; atlas, vol. viii, pl. ii, f. 14, 1857.

Verrill, Amer. Journ. Sci., vol. xi, p. 328 (note), April, 1901; *Pontonidæ*, sp., these Trans., x, p. 579.

The carapax is smooth, curiously banded with black and yellow. In the egg-bearing female it is much swollen laterally. The first and second legs are chelate. The first leg is smaller and somewhat shorter; its carpus is elongated and clavate, longer than the chela. The second leg is much shorter and rather larger, and its chela is strong but not much enlarged; carpus shorter than chela (about one-half as long); hand much longer than claw. Other legs simple, slender, subequal, the last two rather longer. Rostrum short, obliquely truncated; the tip is acute and reaches almost to the end of the ocular peduncle, or to the base of the eye; basal part of the upper edge is short and straight, smooth; it then slopes rapidly to the tip, with about five close teeth. Eye-peduncles project straight forward, and are of moderate length; a spine is situated below and back of its base and above the base of the antenna. The edge of the carapax is cut away at the bases of the antennæ and then extends forward. Abdomen is swollen and the edges overlap in an angle below it, so as to conceal the cluster of eggs.

Color, in life, is conspicuous and characteristic. The carapax and abdomen are covered with many narrow, transverse bands of bright yellow and black of about equal width. The telson is pale yellow with basal and terminal spots of orange. Antennæ purplish blue; eye-stalks light yellow; legs pale yellow, each with two dark blue bands edged with orange; chelipeds with a single, blue carpal band, edged with orange; chelæ pale yellow. This curious species, of which only a few poor specimens have been previously recorded from Bermuda (Amer. Journ. Sci., xi, p. 328, 1901), was taken alive at Hungry Bay, April 5th, 1901, by A. H. Verrill, who made a colored sketch of it.

This specimen is a female carrying a large cluster of eggs.

STOMATOPODA.

Pseudosquilla ciliata Miers.

Pseudosquilla ciliata Miers, Annals and Mag. Nat. Hist., Ser. V, vol. v, p. 108, pl. iii, figs. 7, 8, 1880. Brooks, Voy. Chall., xvi, pp. 58–55, pl. xv, fig. 10, 1886. Bigelow, Proc. U. S. Nat. Mus., xvii, p. 499, 1894. Rankin, Annals N. York Acad. Sci., xii, p. 545, 1899.

P. stylifera Von Martens (t. Miers).

The color of this species is quite variable, like that of *Gonodactylus chiragra*, with which it is often associated. Frequently the colors are imitative of the sandy bottom, the back being variegated or specked with white on a gray or pale yellow ground; in other cases

it is dull yellowish green or dark olive-green, but nearly always there is a pale median dorsal stripe of light gray or whitish, and usually a similar, but less distinct, stripe on each side. Frequently there are three pairs of blackish spots ; one pair on the thorax, one on the first abdominal segment, and another at the base of the telson.

It was not uncommon, swimming near the bottom, in shallow water at Hungry Bay and at Long Bird Island. It was also found in cavities in loose stones, below low-tide. Clusters of its eggs were found in such cavities, April 19th; they were greenish yellow and resemble those of *G. chiragra*, which were found at the same time. This species resembles the latter in form and appearance, but it is usually larger and swims more freely, so that most of our specimens were taken with a hand-net, while swimming. It was not taken by our party in 1898, for lack of information as to its habits.

It can be distinguished at once from *G. chiragra* by its lacking the bulbous enlargement of the chelipeds.

It has been recorded from various parts of the Indo-Pacific region, including the Hawaiian Is., and also from the West Indies.

ARTHROSTRACA.

Cyamus fascicularis V., sp. nov. Sperm-whale Louse

PLATE VIII. FIGURE 4.

Specimens of a slender-bodied *Cyamus*, which is probably a new species, were taken from the body of a young sperm whale, taken off Bermuda and brought to St. George's for exhibition, in April.

This species is much more slender than those of the right whales and allied cetaceans. The two branchial segments are about as wide as the following ones, and bear fascicles of small, short, somewhat unequal branchiæ, scarcely longer than the segments. There are about 10 to 12 branchial filaments in each of the four groups.

The first segment is consolidated with the head, which is narrow and rather long, with conspicuous eyes. Antennæ are about ⅜ the length of the head. First pair of legs small, beneath the second. The hands of the second pair are not much swollen, and have two strong denticles, besides a similar one at the distal angle of the carpus. The three posterior feet have a recurved denticle on the distal angle of the carpus.

Color, yellowish white ; branchiæ have small black spots. The specimens described are females. No males were taken.

Length of body and head, 9^{mm} ; greatest breadth of body, 3.5^{mm}.

Orchestia agilis Smith.

Report U. S. Fish Com. for 1871 and 1872, I, p. 555 [261], pl. iv, fig. 14, 1873.

This abundant New England Amphipod occurs in equal abundance at Bermuda, under decaying sea-weeds at high-tide mark, on all the shores.

CIRRIPEDIA.

Balanus declivis Darwin, var. **cuspidatus,** nov.

Balanus declivis Darwin, Mon. Cirripedia, ii, p. 275, pl. vii, figs 4*a*–4*d*, 1854. (West Indies.)

Our specimens differ as a variety from the typical form described by Darwin, in having the summit of the rostrum divided into 4 or 6 acute denticles; it is very convex and considerably incurved. The summit of the carina is bilobed by a narrow incision. The base is membranous and very obliquely placed, owing to the downward prolongation of the rostrum, as in the type.

Long Bird Island, on the flats, imbedded in a blackish, massive keratose sponge (*Spongia*, sp.), which often lives half buried in the calcareous sand at low tide, and which also harbors a small *Alpheus* and several isopod crustaceans.

This is a very singular barnacle, remarkable for the peculiar oblique membranous base, and the pointed basal end of the rostrum, which are characters developed to suit its mode of life, imbedded up to its aperture in sponges. The type was from the West Indies, in sponges.

Tetraclita porosa (Gm.) Darwin.

Darwin, Mon. Cirripedia, ii, p. 330, pl. x, figs 1–1*m*, 1854.

This is the common, small, sessile barnacle found on the rocks between tides, with the general appearance of some species of *Balanus*. It can easily be distinguished by the 4-parted shell.

Catophragmus imbricatus Sowerby.

Sowerby, Genera of Recent and Fossil Shells, Plate. Darwin, Monog. Cirrip., ii, p 490, 1854.

PLATE VIII. FIGURES 8, 9.

Several specimens of this interesting barnacle were found on littoral rocks. They are all young (about 5 to 8^{mm} in diameter) and agree well with the young one described by Darwin, from Antigua. The eight primary mural plates are pointed and surrounded and partially concealed by about three alternating whorls of smaller, pointed plates, rapidly decreasing in size exteriorly. The opercular

scuta are strongly concentrically ribbed and have a deep, median radial sulcus. The base is calcareous, but thin. The color is pure white.

MOLLUSCA.

CEPHALOPODA.

Loligo Pealei (Lesueur) Bv. Squid.

Loligo Pealei Verrill, Annual Report U. S. Fish Com. for 1879 [pp. 182-161], plates xxvi to xxxii, 1882 ; Verrill, these Trans., vol. v, 1879, pp. 308-340, pl. xxix, figs. 1-4, pl. xxxvii, figs. 1-3, pl. xxxix, fig. 4 ; pl. xl ; pl xlv, figs. 3, 4.

A single specimen of this species, about 6 inches long, was found floating and nearly dead at Long Bird Island, near the shore, April, 1901.

Ommastrephes Bartramii (Les.) D'Orb Flying Squid.

Sthenoteuthis Bartramii Verrill, these Trans , v, pp. 228, 288, 1881 ; Annual Report U. S. Fish Com. for 1879 [pp. 112-114], 1882.

I was told by the fishermen that schools of the flying squid (*O. Bartramii*) are often seen, and that it is sometimes used for bait.

In this connection, it is of much interest to record that among large numbers of the shells of *Spirula Peronii*, cast up on the beach at Elbow Bay, March 10th, several were found by A. H. Verrill with portions of the flesh still attached. Two of these were preserved in formalin, with the remnants of the animal. This proves that this species lives not far away from that shore, and it may be abundant just outside the reefs, in rather deep water.

GASTROPODA.

TECTIBRANCHIATA.

Dolabrifera ascifera (Rang) Morch.

Aplysia (*Dolabella*) *ascifera* Rang, Hist. Nat. Aplys., p. 51, pl. iv, figs. 7-9

Dolabrifera ascifera Morch, Mal. Bl., xxii, p. 176. Sowerby, Conch Icon., xvi, pl. i, figs. 6a, 6b. Pilsbry, Man. Conchology, xvi, pt. 63, p. 124, pl. xxxiv, figs. 17, 19, 20. 29 ; pl. lxv, figs. 10, 11. Berg., Verh. k. k. Zoöl. Bot Gesellsch., Wien, xxii, 1872, p. 441, pl. v, figs. 25-29 ; pl. vi, figs. 1-10, anatomy.

PLATE II. FIGURES 6a, 6b. PLATE III. FIGURE 2. PLATE IV. FIGURE 12.

A rather small, ovate, light-colored species, the body covered with small, low, rounded verrucæ ; the head with small papillæ.

Body depressed, broadly rounded posteriorly; foot broad, the edges thin and undulated. Mantle-lobe over the gill-cavity is short, leaving an open sinus at each end of the cavity. Tentacles and rhinophores about equal in length and similarly folded, the tentacles broader or more expanded distally.

Color of upper surface pale yellowish gray and brown, or light fawn-color, mottled with yellowish white; head paler. Under side of foot blue with white spots.

Length, 60^{mm}, in life; breadth, about 30^{mm}. The shell is narrow, oblong anteriorly, elongated, with a much produced beak, which is tapered but blunt. The sinus is slightly concave and about ½ the total length of the shell, ending in a very obtuse angle. The anterior and inner margins are nearly parallel, narrowing slightly anteriorly; the anterior edges obliquely truncate, with rounded angles.

Hungry Bay, April 5, 1901, under stones at extreme low-tide. Two specimens found together, as if breeding. (A. H. V.)

Dolabrifera virens V., sp. nov.

PLATE II. FIGURES 4*a*, 4*b*, 5*a*, 5*b*. PLATE IV FIGURE 11.

FIG. 1—*Dolabrifera virens* V. About ½ natural size.

A rather large, yellowish green species, covered with small, elongated, conical, acute or distally branched papillæ.

Body broad-ovate, broader and well rounded posteriorly; the whole upper surface of the body and head is covered with conical papillæ, 1 to 2^{mm} long, part of which are acute at tip and part are divided at the end into 2 to 4 small branches. Rhinophores shorter and much smaller than the tentacles, deeply folded and enlarged at the ends. Tentacles very large, elongated, with broadly expanded ends, the edges undulated and thin. Mantle-lobe rather small, nearly semicircular, leaving a small open sinus at each end of the branchial cavity.

Color above, in life, dull yellowish green, with ill-defined blotches of pale brownish, and with white spots; the papillæ are mostly lighter and more yellow; margin pale bluish with white specks; under

surface olive-green, spotted with white. Rhinophores green, with white spots and edges.

Length, in life, up to 100^{mm}; breadth, about 50^{mm}.

The shell is firm, calcareous, rather oblong, with the beak produced and grooved or sometimes spoon-shaped, being concavely excavated; the sinus is incurved and has the inner margin thickened; anterior end obliquely truncated and angular; a thin, high, median, vertical crest or keel runs about $\frac{1}{3}$ of the length, on the inside. Left margin nearly straight or slightly incurved. The outer surface is faintly radially ribbed. The shell varies considerably in form in the several examples examined, and especially in the ratios of length to breadth, as shown in the two figures given The beak may be acute or spoon-shaped; in one it was wholly lacking, due apparently to injury and partial repair. In one specimen the shell was in two parts, having been broken before death and only slightly repaired.

Hungry Bay, under stones at low tide, April 5, 1901, 5 specimens. (A. H. V.) Another specimen was taken in May by Mr. W. G. VanName.

Tethys (Aplysia) morio V., sp nov

PLATE III FIGURES 5, 5*a*

A very large species, over a foot long, dark umber-brown or nearly black, without definite spots, but with black stripes on the head, and with very large broadly overlapping lateral flaps.

Body thick and stout, swollen, very obtuse posteriorly. Head and neck thick and stout (but perhaps not seen fully extended). Lateral natatorial flaps very wide and overlapping about half their breadth, entirely free posteriorly, and extending to the end of the short foot. Rhinophores rather small and short, conical. Tentacles large and very broad, foliaceous, with thin expanded margins.

Color of body and exterior of flaps very dark umber brown or brownish black, with few obscure dusky blotches on the sides of foot and with a purplish tinge along the edges of the flaps. Head, above and on the sides, covered with a number of narrow, purplish black, longitudinal stripes.

Length, in life, when not fully extended, 400^{mm}; height, 145^{mm}.

The shell is very thin, transparent, pale yellow, oblong-ovate, obtusely rounded anteriorly, with the posterior sinus long and only slightly incurved; beak rather prominent, scarcely incurved, with a reflexed membranous edge, which also extends along both posterior margins. In the formalin preparation there is no calcareous layer present. The surface is concentrically undulated and faintly longi-

tudinally grooved. Length to breadth as 3 : 2. Length, 60^{mm}; breadth, 40^{mm}.

No mantle-pore could be found, nor any distinct pore for the "opaline gland"; the latter probably discharges through many minute pores.

A single specimen was found in Castle Harbor, March 21, cast upon the beach but still living and not damaged. (A. H. V.)

This species resembles *T. megaptera* V., in the great size of its lateral flaps, but differs very decidedly in its colors and other characters.

Tethys (Aplysia) tarda V., sp. nov.

PLATE III. FIGURES 4, 4*a*, 4*b*

A rather small, short, thick species, with relatively narrow side-flaps and short rhinophores; dusky yellowish brown, irregularly streaked with darker brown or blackish on the head and sides.

Body ovate, obtuse posteriorly, the foot not produced. Head small, emarginate; neck short and thick. Rhinophores short, subconical, tapered. Tentacles larger and rather longer, wide at base, deeply folded. Side-flaps unusually narrow, scarcely meeting over the back, and apparently not capable of being used for swimming, the edges undulated and free to the posterior ends, which extend nearly to the short tip of the foot. Branchial siphon elongated, expanded distally. Mantle over shell with a small, simple, nearly central pore, often with white streaks, or rows of white spots, radiating from it.

General color usually is dark dusky brown or umber-brown. The ground-color is a dull, dark yellowish brown on the sides and head, but irregularly blotched, striped and streaked with dark, dusky brown or sepia. The streaks on the head mostly take the form of narrow lines, those on the sides of the body are broader and more irregular, and are united by transverse lines, so as to form a coarse, irregular reticulation. Edges of side-flaps and siphon bluish gray with a purplish tinge, or grayish white. Inner surface of flaps dark brown with dark gray blotches. Shell-mantle dark brown, irregularly spotted with grayish white, some of the spots usually arranged radially around the central pore. Siphon similar in color. Tentacles and rhinophores light brown, with transverse patches or lines of dark brown.

Length, in life, 62^{mm}; height, 30^{mm}.

The shell is thin, translucent, pale yellow, ovate-elliptical, rather narrow, ratios as 3.2 : 2; the posterior end is produced, with the

beak rather acute, not incurved, but with a small, narrow, reflexed terminal and marginal fold; posterior sinus rather long, decidedly incurved, ending anteriorly in a broadly rounded angle; the anterior half of the shell forms about half of a regular ellipse. In the formalin preparation there is a thin, white posterior calcareous layer, that has mostly fallen off. The surface is slightly undulated concentrically. Length, 32^{mm}; breadth, 20^{mm}.

Cony Island, buried in sand nearly out of sight, April 4; also at Long Bird Island, in shallow water, in May, buried in sand, with only the back slightly exposed. (A. H. V.)

This species seems to live habitually nearly buried in sand. It is very sluggish and probably cannot swim freely, at least in confinement it made no effort to swim. Its back, as exposed, resembles in color a keratose sponge found in the same localities and partly buried in the sand.

In color and form this species somewhat resembles *T. Floridensis* Pilsbry (Man. Conch., xvi, p. 82, pl. xxxvii, figs. 15-19), but the latter is described as having the side-flaps "ample," while in the present species they are unusually small. The shell of *Floridensis* is wide, and quite different in form, being nearly as broad as long, while in our species it is unusually narrow. In respect to the form of the shell, *T. Braziliana* D'Orb. is much like this, but it has large side-flaps, a tubular mantle-pore, a long neck, and other differential characters.

Tethys dactylomela Rang.

Verrill, these Trans., x, p. 545, 1900.

PLATE III. FIGURE 3.

This was very common this year on the shores of Castle Harbor, breeding in April. Its eggs were laid in clusters of long thin, terete, yellow strings, attached by one end to weeds; the eggs are very small and very numerous, in 6 to 8 rows. The colors were generally as ordinarily described, the ground-color varying from light yellow to dark olive-green. A few that were nearly albinos were seen, and one that was melanistic, the ground-color being so dark that the round black spots were barely visible.

Placobranchopsis niveus V., sp. nov.

PLATE IV. FIGURE 10.

A very small, nearly pure white species. Mantle broad-elliptical, slightly emarginate anteriorly, and with a distinct lateral branchial

sinus; its surface is minutely papillose and rough. Head broad, with the angles somewhat produced into short, broad tentacles. Rhinophores stout, rather long, strongly folded, of nearly uniform breadth, obtuse. Foot wider than the mantle, and only slightly longer, the edges thin and undulated, the anterior angles a little produced but obtuse. Gill plumose, attached for about half its length, white. The mantle contains spicules, but, as preserved in formalin, it is soft and rather thick.

Color pale grayish white or translucent white, specked with flake-white, and with a purplish gray visceral organ showing through on the back.

Length, in life, 16^{mm}.

Harrington Sound, in shallow water, on the under side of a coral (*Isophyllia dipsacea*), April 9th; also in Castle Harbor, low-tide, under stones, in May.

Runcina inconspicua V., sp. nov.

PLATE III. FIGURE 6.

A very small dark green and brown species. Head bilobed and emarginate in front with a pair of small, round black eyes near the front edge. Mantle oblong or subelliptical, evenly rounded posteriorly. Foot wider than mantle, with thin undulated margins, well rounded posteriorly. Gill small with fine filaments situated under the right mantle-border, near the posterior end.

Color of mantle very dark green or greenish brown with a narrow orange border; upper side of foot light green, specked with white and edged with a narrow orange or violet line.

Length, 2 to 3^{mm} in life.

Castle Harbor, at low-tide, under stones, in May. Several specimens.

NUDIBRANCHIATA.

Elysia ornata (Swainson) Ver.

Thallepus ornatus Swainson, Treatise Malac., pp. 250, 359, 1840, from a drawing, (West Indies.)

Dalabrifera (?) *ornata* Pilsbry, Man. Conchology, vol. xvi, p. 126.

PLATE IV. FIGURE 5.

This beautiful species was originally imperfectly described, as indicated above, from the West Indies. The description was from a colored drawing only, and was so imperfect that the place of the species in the Mollusca has never been settled. The colors, as

described, are so characteristic and striking that there can be no doubt of its specific identity with our specimens.

The body, in life, is usually yellowish olive-green, but it varies from light yellowish green to dark olive-green ; both surfaces of the flaps and the sides of the body are finely specked with black and flake-white dots, often appearing to be slightly raised above the surface. The side flaps are wide with thin flexible and usually undulated margins, which are elegantly bordered with a narrow bright orange band, outside of which the edge is marked by a black line. The folded rhinophores are large and long, with the posterior side orange and the edge black. There is often a white patch on the top of the head. Under side of foot paler green than the body.

This interesting species was found pairing, and spawning in considerable numbers on the shore of Castle Harbor in March, by A. H. Verrill. It occurred mostly on a curious bright green alga (*Caulerpa clavifera*), on which it laid its eggs in a long coiled ribbon. According to the notes, the egg-band, when first laid, floated freely in the water, being attached only by the proximal end, but it was afterwards cleverly coiled up and attached for its whole length by the parent, before being left to its fate. The species became comparatively rare in a few days, perhaps retiring into deeper water. Only a very few could be found at the same place after my arrival in April. The last specimens seen occurred April 17th.

Elysia subornata V., sp. nov.

PLATE IV. FIGURE 4.

Head large ; body elongated, acute behind ; neck long in extension. Rhinophores large and long, folded and strongly expanded at the tip. Side flaps large, pointed posteriorly ; their outer surfaces and the sides of the body are covered with small scattered verrucæ.

Color of body and outside of flaps olive-green, finely mottled with grayish white. Close to the edge there is a very narrow orange-brown line ; the extreme edge is darker brown. Inner surface of flaps dark green with pale dendritic and inosculating vessels. Rhinophores marked distally with brown ; more proximally there is a gray patch ; base green specked with gray.

Length, up to 25^{mm} in extension.

Castle Harbor, under stones, in May. Rare.

This species is evidently closely allied to *E. ornata*, but the latter was very constant in its markings, in over 200 specimens examined,

and did not show, in any case, the distinctly, though minutely, papillose surface of this species, which also appeared later and with somewhat different habits.

Elysia flava V., sp. nov,

PLATE IV. FIGURE 1.

Body much elongated in extension ; head relatively small, bilobed in front. Rhinophores rather small, about as long as the breadth of the head, folded but not much expanded distally. Side flaps moderately wide, undulated, rounded anteriorly, narrow posteriorly, and extending nearly to tip of the pointed foot.

Color of head, neck, rhinophores, back, and foot light yellow, with white specks on the back, and faint dull brown markings back of the head and on the sides of the neck. Outside of the flaps olive-green, specked with white and covered with very minute papillæ ; edges of flaps flake-white, with dendritic branches of white extending inward. Inner surface of flaps are almost black, due to the very dark or blackish green, arborescently branched internal organs.

Length, about 18^{mm} while living and in extension.

Castle Harbor, at Waterloo, under stones at low-tide, April 17, 1901. Rare.

Elysia picta V., sp. nov

PLATE IV. FIGURE 2.

A small, very brilliantly colored species. Body rather stout. Head large and neck rather long ; rhinophores long, clavate, and deeply folded ; their length is equal to twice the breadth of the head. Side-flaps large and broad, their edges thin and strongly undulated ; they extend posteriorly to the tip of the foot.

Color of upper side of head, upper part of sides of neck, and whole of back and inner surface of flaps dark reddish brown, with a purplish spot between anterior ends of flaps ; front of head bright red; a line of the same red runs back on each side of the neck and along the entire edge of the flaps to the end of the foot ; below this red border there is a band of bright blue ; middle of head and bases of rhinophores light yellow, and this color extends backward as a broad median stripe on the neck, thus forming a cross-shaped mark of yellow, which terminates posteriorly in a blue spot on the neck, and in a blue band on each rhinophore ; on the latter the blue is followed by a brown band, this by a wider red band, while the tip is brown. A blue spot centered with yellow surrounds the genital openings, on the right side of the neck.

Outer surface of lateral flaps olive-green below, becoming yellowish above, and nearly white next to the blue submarginal band; its surface is thickly specked with yellowish white.

Length, 16^{mm}; length of rhinophores, 3.5^{mm}.

Hungry Bay, April 5, 1901, under stones at low-tide; two specimens, pairing. (A. H. V.) Very rare.

This species can be recognized at once by its many brilliant colors, and especially by the marginal bands of red and blue, and by the yellow cross on the head and neck. It can swim freely by means of its large side-flaps.

Elysia papillosa V., sp. nov.

PLATE IV. FIGURE 3.

A small, grayish, distinctly papillose species. Body rather elongated in extension; head large; neck long; rhinophores large; strongly folded and wide at the tips. Side-flaps large, thin, usually with the edges deeply undulated. Whole surface of body, head, and outside of flaps thickly covered with small conical papillæ.

Color of head, neck, and outside of flaps grayish blue, paler anteriorly, and spotted with darker gray on the outside of the flaps, and specked with flake-white over the whole surface. Inside of flaps darker ash-gray; the edges bordered with white. Rhinophores are like the head, but with two indistinct transverse bands of orange-brown on the posterior side.

Length, about 12^{mm} in extension.

Hungry Bay, under stones, at a very low-tide, April 5, 1901. (A. H. V.) Rare.

This species can swim freely by means of its ample lateral flaps.

Lamellidoris aureopuncta V., sp. nov.

PLATE IV. FIGURE 9.

A very small, nearly white species, with a row of small, round, yellow spots near each lateral edge of the mantle.

Body elliptical, obtuse at both ends. The foot is longer and wider than the mantle; anteriorly it is subtruncate with obtuse angles, posteriorly it is rather obtuse and not much produced. The mantle is evenly convex, nearly smooth, but hardened by spicules.

Rhinophores small, slender, acute, with many oblique plications and no distinct sheath. Gills 6 or 7, simply pinnate, with fine branches, retractile.

Color of mantle and foot and gills pale, translucent, yellowish white, with whiter specks, due to spicules; near each lateral margin of the mantle there is a row usually of five small, round, golden yellow spots, to which the name refers. A greenish visceral organ often shows through on the back. Rhinophores yellowish.

Length, 10^{mm}; breadth, 5^{mm}, in life.

Harrington Sound, in shallow water, under corals, April 28, 1901.

Lamellidoris miniata V., sp. nov.

PLATE III. FIGURE 1

See figure 8, below

A small, bright red, finely papillose species. Head rounded, emarginate in front, with a pair of slender oral tentacles. Body elliptical, strongly convex. Foot thin, wider and much longer than the mantle, its anterior angles produced into folded lobes. Rhinophores rather large, fusiform or subclavate; thick and strongly plicated, basal part smooth; tip naked, acute and white; no evident sheaths. Gills about eight, rather large, simply pinnate, with fine filaments, retractile. Surface of mantle covered with minute, conical, pointed papillæ.

Color of mantle bright red or deep orange-red, with an obscure median brownish stripe; gills and middle of rhinophores darker red, surrounded at base with grayish blue; the rhinophores are tipped with white. Foot and head paler orange or pinkish.

Length of foot, of largest, in extension, 10^{mm}; of mantle, $7{\cdot}5^{mm}$; another was 6^{mm} long, $3{\cdot}5^{mm}$ broad.

Castle Harbor, under stones at low-tide, April 10th and 17th, 1901.

Lamellidoris lactea Ver.

These Trans., x, p. 548, 1900.

PLATE IV. FIGURES 8*a*, 8*b*.

A few additional specimens of this rare species were obtained. In these the dorsal surface of the mantle and the sides below its border were milk-white, spotted and specked with purplish gray or pale lavender, some of the spots near the middle being larger and roundish; there was a tinge of orange around the bases of the gills and on the low thick sheaths of the rhinophores. The gills are rather long, simply pinnate; about 7 to 9 were counted. The rhinophores are small, conical, dark gray.

Lamellidoris (?) *olivacea* V.

Doris (?) *olivacea* Verrill, these Trans., x, p. 548, 1900.

PLATE IV FIGURE 7.

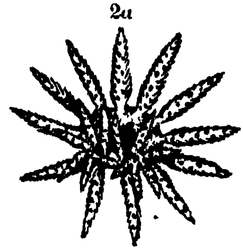
A larger and better specimen of this species was obtained this season. The central area of the back, in this example, is covered with small, conical, whitish or grayish papillæ. The rhinophores are long, tapered, subacute, with an orange ring at base. The wide undulated mantle-border contains spicules.

Chromodoris (?) *roseopicta* V.

These Trans., x, p. 549, pl. lxvi, fig. 1, 1900.

2

2a



3.

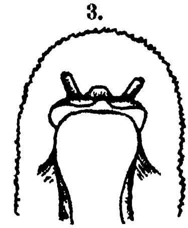


FIG. 2.—*Chromodoris roseopicta* V., gills in profile, enlarged. 2*a*.—The same, posterior view of gills. 3.—*Lamellidoris miniata* V. Head and front part of foot, enlarged.

Larger and better specimens of this beautiful species were obtained this year; they show that some of the characters of the type-specimen were due to immaturity or imperfect expansion.

In the best examples the mantle border is broad, strongly undulated, and projects beyond the margins of the foot. The back is everywhere covered with prominent rosy-tipped, rather blunt papillæ; some of these, larger than the rest, form three rows of 5 or 6 along the back, and these are surrounded at base with bright yellow specks. The rhinophores, in expansion, are clavate-fusiform, stout, subacute, plicated, bright red, striped with narrow lines of white spots. The gills are large and long, about 24; of these 12 or 14 are simple, long, tapered, pinnate plumes; behind and within these there is, on each side, a group of 5 or 6 smaller divergent plumes, which arise in a subspiral manner from a common stem.

The color, in general, is the same as in the type.

Harrington Sound, Hungry Bay, Long Bird Island, etc., usually on the under side of a massive, brown keratose sponge (*Spongia*, sp.)

Scyllæa pelagica (Linné).

A single large living specimen of this species was found at Long Bird Island, on the flats, in May. Its color was light orange, with a marginal band of deep orange, edged with white around the lateral lobes and along the upper lateral margins of the body; sides of body were specked with flake-white, but without purple spots. Back of rhinophores deep orange; edges white.

Length, 35^{mm}.

Facelina Goslingii V., sp nov

Plate IV. Figure 6

Body, in life, when extended, elongated and rather slender, tapered to an acute point posteriorly. Head large, rounded, with a pair of very long, slender, tapered, acute tentacles. Rhinophores much smaller, not half as long, acute, with strong plications on the distal portion, naked near the base. Foot with the anterior angles prolonged into a pair of long, tapered, tentacle-like organs, more than half as long as the true tentacles and similarly colored. Dorsal papillæ numerous, long, very slender, fusiform, acute, easily deciduous, arranged in numerous (about 10 to 12) double groups along each side, leaving a broad naked dorsal region. The anterior groups contain numerous crowded papillæ, in two or more transverse rows; the posterior groups gradually diminish till the last contain very few papillæ.

Color of back pale, translucent, grayish white, with a median stripe of white, edged with narrow red lines, and with a lateral stripe of orange on each side along the bases of the papillæ, which are white crossed by numerous bands of light rose-red or pink. Head white in front, tinged with pink around the mouth and with a median, usually Y-shaped streak of red on the front and extending between the tentacles, and an ocellated, round, blue spot at the upper base of each tentacle; back of neck with a median blue streak. Tentacles and tentacular processes of foot white proximally, then with a light red band followed by a wide blue distal band. Rhinophores nearly white. Foot edged with blue anteriorly.

The odontophore has but a single row of teeth; these have broad, thick bases and taper rather rapidly to the acute, naked, somewhat incurved tips. There are about 10 to 12 acute serrations on each edge, the distal ones becoming very small. The cutting edges of the jaws are brown and chitons with a submarginal rib; the two edges form nearly a right angle, when flattened by pressure.

Length, in life, 35 to 45^{mm}.

Taken in considerable numbers in the mangrove swamp at Hungry Bay, on a filamentous green alga, March 10th, 1901 (A H. V.). In April (5th) both the alga and the mollusk had disappeared.

This is a very handsome and active species. It is difficult to preserve entire, for it casts its papillæ very readily when irritated in any way.

It is named in honor of Mr. T. Goodwin Gosling, of Bermuda, who first discovered it. I have referred it to *Facelina* with some doubt, for its anatomy has not yet been fully studied.

PROSOBRANCHIATA.

Volva uniplicata (Sowerby).

Ovulum uniplicatum Sowerby, Proc Zool Soc London, 1848, p 185
Volva uniplicata Tryon, Amer Marine Conch, p 93, pl ix, fig 93, 1873

The purple variety of this species was found adhering to a purple specimen of *Gorgonia flabellum*, from Castle Harbor reefs.

PULMONATA.

Among the Pulmonata, apparently not before recorded, are the following.

Melampus bullimoides Mont Shore of Hungry Bay
?**Blaumeria heteroclita** Mont Shore near Hungry Bay, under stones.

Also an undetermined, small, strongly depressed, smooth, helicoid shell, 8 to 10^{mm} in diameter; the aperture is simple, lunate; lip acute; umbilicus open and deep, but not very large. Hamilton, in gardens.

BIVALVIA.

Cardium medium Linné

A single dead specimen of this West Indian species was found in the cavities of a stone fished up from about 100 feet deep, off the outer reefs.

ECHINODERMA.

Only one species, so far as positively determined, was added to the Echinoderma this year. This was an interesting simple-armed astrophytid (*Astroporpa affinis*), which was found clinging to a *Verrucella* from off the outer reefs.

Several other species of special interest were obtained, which we did not collect in 1898.

OPHIUROIDEA.

Astroporpa affinis Lutken.

Lutken, Addit ad Hist. Ophiur., II, p 154, pl. v, figs 5*a*, 5*b*, 1859.

Four specimens of this rare species were found clinging to the branches of a large gorgonian (*Verrucella grandis* V.), brought up from about 100 feet, off the outer reefs, on a fisherman's hook. The color, as dried, after a few days, is light yellowish or grayish-brown on the raised annulations of the arms and ribs, and darker brown on the annular grooves.

ASTERIOIDEA.

Luidia clathrata (Say).

Asterias clathrata Say, Journ Acad. Nat Sci Philad, v, p 141, 1825
Luidia clathrata Lutken, Vidensk. Meddel, p 37, 1859 A Agassiz, N Amer Starfishes, p 117, pl xx. Perrier, Arch Zool. Exper., v, p 252, 1876. Sladen, Voy. Challenger, Zool., vol. xxx, pp 245, 358, 1889.

Several fine specimens of this species were taken on a white shell-sand bottom in shallow water, at Trunk Island, Harrington Sound It also occurred at Long Bird Island and other localities, on shell-sand bottoms in shallow water. Its presence is indicated by a star-shaped impression in the sand. But it moves about under the sand with remarkable rapidity, when disturbed, by means of its large ambulacral tubes, so that it is not easy to capture it, after it has taken alarm.

Its color in life is generally light cream-color, often with a rosy or flesh-colored tint, and frequently with a darker grayish or greenish median streak on each ray. It becomes at least a foot in diameter at Bermuda.

Linckia Guildingii Gray.

Linckia Guildingii Gray, Ann and Mag. Nat Hist, vi, p. 285. Perrier, Arch. Zoöl. Exper., iv, p. 408, 1875. A. Agassiz, N. Amer. Starfishes, p. 105, pl. xiv, figs. 1–6. H. L. Clark, Ann. N. York Acad., xi, p. 412, 1898. Verrill, these Trans., x, p. 671. (*Ophidiaster*, by error, on p. 584.)
Ophidiaster ornithopus Müll. & Troschel, Syst. Aster., p. 31, 1842.
Linckia ornithopus Verrill, these Trans., vol i, p. 367.

Several small specimens of this species were taken, mostly at Hungry Bay and Long Bird Island, under stones below low-tide. It is dull orange or orange-brown in life.

ECHINOIDEA.

The most interesting species of this group, taken this year, is the following :

Echinoneus semilunaris (Gm.) Lam.

Echinoneus semilunaris Lam., Anim. s. Vert., p. 19, 1816 A. Agassiz, Revis. Echin., p. 118 (Syn.), 338 (descr.), 550, pl. xiv, figs. 1–5, pl. xxxviii, fig. 26, 1872.

Echinoneus gibbosus Lam., Anim. s. Vert., p. 16, 1816.

Echinoneus elegans Desor, in Agassiz, Mon. Echin., p. 47, pl. vi, figs. 4–6, 1842.

Echinoneus conformis Desor, op. cit., p. 48, pl. vi, figs. 11–21, 1842.

This interesting species appears not to have been obtained there for many years, though it was recorded by Mr. A. Agassiz. Two living specimens were taken at Hungry Bay in March, by A. H. Verrill. They were found buried in sand and gravel, under stones, in small tide-pools, at extreme low-tide. Their color in life was purplish red or bright copper-red.

HOLOTHURIOIDEA.

Holothuria Rathbuni Lampert.

Holothuria, sp., Rathbun, these Trans., v, p. 141, 1879. (Description.)

PLATE I. FIGURES 6*a*, 6*b*, 7.

The most interesting holothurian was a large species of *Holothuria* which has the habit, unusual in this genus, of burrowing deeply in the sand at and below low-tide mark on the sand flats, much like the *Arenicola cristata*, with which it is usually associated. It makes a distinct mound of sand around the mouth of its burrow, which runs obliquely downward, often to the depth of two feet or more.

This holothurian itself, when expanded, was often 18 to 20 inches long and 1 inch to 1½ inches in diameter in the middle.

It is usually long-fusiform in extension, tapering gradually to each end. Its color is usually gray, pale grayish brown, or purplish brown, with irregular rows of roundish brown or purplish spots. It is often stained with rusty brown or yellow. The surface is papillose, and the integument is firm and tough.

This was not uncommon on the flats exposed at low-tide at Long Bird Island, and other similar localities. A single specimen was in Mr. Goode's collection of 1876, without special locality.

This is probably *H. Rathbuni* Lamp., recently recorded from Bermuda by Mr. H. L. Clark (Proc. Boston Soc. N. Hist., xxix, pp. 343, 344, May, 1901).

ANNELIDA.

CHÆTOPODA.

An important collection of marine annelids was made this year, but it has not yet been studied in detail. A number of new forms are known to be included in the lot. Among the additional genera are *Terebellides*, *Pterosyllis*, and others.

Several interesting species of earthworms were also obtained, but they have not yet been examined with care.

The following large and handsome new *Pectinaria* was found in considerable numbers:—

Pectinaria regalis V., sp. nov.

PLATE VIII. FIGURES 6, 7.

A large, stout species, with large groups of bright golden, acute opercular setæ, of which there are 11 to 13 in each group, the outermost and two to four of the inner ones much smaller than the rest.

Opercular disk broadly rounded, smooth, with the dorsal edge crenulated, and with a slender acute antenna on the ventro-lateral angles; a stouter, bent, obtuse lobule stands at the base of the ventral edge, on each side. The ventral lobe has about ten slender marginal papillæ on each half of the ventral edge, besides three or four smaller ones on the incurved lateral edges.

The buccal segment bears a pair of slender tentacular cirri, longer than the antennæ, and below these, on each side, four rounded prominent lobules. The gills are large, the anterior pair much the larger; below each gill there is a prominent transverse ridge separated below by a median glandular pad. Similar ridges occur on the next two segments, but the fourth ventral pad is bilobed.

On fifteen segments, following the 2d branchial, there is a conspicuous dorsal fascicle of golden setæ, largest on the 3d to 9th. The two next segments appear to lack dorsal setæ; the next (last thoracic) has a small group of recurved setæ on the dorsal side. The caudal region has five segments, besides the caudal, which is semicircular, with about 24 rounded marginal papillæ. Rows of uncini begin on the 4th post-branchial segment.

Length, up to 95^{mm}; diameter, 12–13^{mm}.

The tube is regularly tapered and considerably bent; it is composed of rather large, nearly uniform, rounded grains of calcareous sand. This fine species was found at Cony Island and the "Scaur," between tides, in shell-sand. Very local.

Arenicola cristata Stimpson.

Proceedings Boston Soc. Nat. Hist., v, p. 114 Webster, Bull. U. S. Nat. Mus., No. 25, p. 323, 1884.

This large species was very common at low-tide and down to three fathoms at several localities, especially at Long Bird Island on the flats, Castle Harbor at Waterloo and Tuckers Town, at Hungry Bay, etc. It makes a conspicuous burrow, at the mouth of which there is usually a long cylindrical or coiled roll of mucus, nearly an inch in diameter.

Fallacia protochona (Schmarda) Quatr.

Hesione protochona Schmarda, Neue Wirb. Thiere, I, p 79, pl xxviii, fig 226, 1861 Quatrefages, Hist. Nat. des Ann , II, p. 98, 1865. Webster, op cit., p. 311, pl. viii, fig. 21, 1884

PLATE VIII. FIGURE 5.

Some large and fine specimens of this species were taken in 1901. Some of them were at least six inches (150^{mm}) long while living. They were mostly found under stones at low-tide at Hungry Bay, the Scaur, Cony Island, Castle Harbor, etc.

Some of the largest were found swimming rapidly at the surface, by rapid undulations of the body.

In life the color is pale brownish yellow, striped longitudinally with many fine dark brown lines.

GEPHYRÆA.

Sipunculus nudus Linné (?)

Selenka in Semper's Reisen in den Philippinen, ii, Bd. iv, 1883.
Ward, Bull. Mus. Comp. Zool., xxi, pp. 147–182, 1891.

A large species, 200 to 250^{mm} in length and 15 to 20^{mm} in diameter when expanded. It contracts variously in formalin, sometimes to a cylindrical form, 150^{mm} in length and 10 to 12^{mm} in diameter ; in other cases the middle of the body is much narrower and both ends are bulbous.

The body is longitudinally sulcate, with about 32 grooves, separating wider muscular bands. These are crossed by numerous circular grooves and bands, which divide the surface into more or less conspicuous squarish or oblong areas, which are often distinctly raised, especially posteriorly. The posterior end is suddenly tapered to an obtuse point, the tapered portion being nearly smooth, but longitudinally sulcated ; that portion of the base of the proboscis which is visible is closely covered with small broad-based, obtuse, conical, pale brown verrucæ.

The anus is a conspicuous transverse slit, on a slightly raised or thickened brownish area, covered with radial grooves. The nephridial pores are very distinctly transversely bilabiate ; they are separated by about seven longitudinal muscular bands, and are situated on the eighth muscular band in front of the anal pore.

The color in life is brownish flesh-color, or light yellowish brown. In formalin it is dull, pale yellowish brown, a little darker on the posterior end and at the base of the proboscis, as well as around the anal pore ; the surface has a glistening appearance.

One specimen is somewhat darker, being covered with fine dark brown specks, which form alternately lighter and darker, very narrow stripes on the body, two narrow dark lines being situated on each longitudinal muscular band.

The internal anatomy has not yet been studied sufficiently to determine positively whether this be identical with the European *S. nudus*, which has been reported also from Florida.

Sand flats of Long Bird Island, in deep burrows, April, 1901.

Physcosoma, sp

A large species, 150 to 175^{mm} long, and about 8 to 10^{mm} in diameter, when expanded.

It was translucent flesh-color, finely specked with yellowish brown. The two long and large segmental organs showed through the integument as purplish folded tubes 20 to 30^{mm} long.

There are 20 wide muscular bands ; seven on each side between the anal and nephridial pores and six between the two latter. The surface is covered with fine granule-like elevations ; around the posterior end is a wide zone of larger, crowded, low, yellow, rounded verrucæ, not chitinous ; a similar zone surrounds the base of the proboscis. On the inner surface of the longitudinal muscles are scattered, oblong, low, verruciform bodies, about .5^{mm} long. The intestine is long and large, forming about 45 spiral turns. The transverse muscles form thin narrow bands or lines, very near together.

Thalassema Baronii Greef.

Thalassema Baronii Greef, Acta Ac. Germ , xli, p. 151, 1879. Shipley in Willey's Zoöl. Results, part iii, p. 745, pl. xxxiii, figs. 1 and 7, 1899 ; Proc. Zoöl. Soc. London, 1899, p. 55 Selenka, Challenger Voy., Zoöl., xiii, p. 1.

PLATE V. FIGURE 9.

Length, in life, in extension, 50 to 65^{mm}, diameter 12 to 15^{mm}, but the form is very changeable. The color of the body was bluish-

green, striped longitudinally with about eight bands of bright pink or light violet-red, these stripes being of nearly the same breadth as the green ones. Proboscis similar to the greenish parts of the body, but rather lighter, or more distinctly bluish, without stripes.

The body, in expansion, was usually thick-fusiform or larger in front of the middle. The proboscis was usually short, stout and blunt, but changeable according to state of expansion.

Three specimens were collected on one of the serpuline atolls near Hungry Bay, at a very low tide in March. They were imbedded in loose sand and gravel. (A. H. V.)

TURBELLARIA.

POLYCLADIA.

Thysanozoön nigrum Girard.

Thysanozoon nigrum Girard, Proc. Boston Soc. Nat Hist , vol iv, p 137, 1854 (from Cape Florida).

Thysanozoön Brockii, var nigrum Lang, Die Polycladen, Fauna und Flora des Golfes von Neapel, p. 535, 1884

A large, nearly jet black species, thickly covered above with large obtuse or subacute, unequal papillæ.

Body broad, oblong-elliptical, with thin undulated margins, used actively in swimming. Tentacular lobes elongated, projecting upward and forward, deeply folded. A small, roundish or cordate cerebral cluster of minute ocelli, surrounded by a small pale area. Whole dorsal side covered with rather closely crowded papillæ, part of which are much smaller than the others; they are mostly tapered and rather obtuse, but many are fusiform and subacute.

Color usually nearly pure black, sometimes with patches of dark gray and fine specks of white, and with faint yellowish reticulated lines anteriorly; under side light smoky brown. Papillæ blackish, often tinged with greenish yellow.

Length, in life, up to 60^{mm}; breadth, 30 to 45^{mm}.

Castle Harbor and Harrington Sound, in May, usually found swimming actively at the surface, but sometimes living under stones

It was called "sea-devil" by some of the fishermen, probably owing to its black color.

Thysanozoön griseum V., sp. nov.

PLATE V. FIGURE 7.

Body usually oblong-elliptical or ovate in extension, but changeable. Length to breadth often as 2:1. Dorsal surface thickly cov-

ered with elongated, acute, unequal papillæ. Tentacular folds prominent, not very near together. Cerebral ocelli form two slightly separated, small, nearly semicircular groups, surrounded by a pale area. Color of dorsal side mostly brownish gray, tinged with yellow, and with a broad median stripe of white, on which the papillæ are also white ; the other papillæ are spotted with orange, white, and dark brown. Tentacles gray, spotted with flake-white. On their anterior edges there are, apparently, many minute black ocelli ; other black specks that may be ocelli form a row on the front margin, between the tentacles and on the lateral margins as far back as the cerebral ocelli, or farther.

Length, 35 to 40^{mm} ; breadth, 16 to 20^{mm}.

Harrington Sound, under dead corals, in April.

This may, perhaps, prove to be only a pale variety of *T. nigrum*, when a larger series can be studied, but aside from the difference in color, the separate groups of cerebral ocelli and the more prominent tentacles seem to be important characters. Only one specimen was taken.

Pseudoceros bicolor V., sp. nov.

PLATE V FIGURE 5

Body broadly elliptical with very thin undulated edges. Pseudotentacles are broad, short, rounded folds with a deep sinus between them, and with numerous minute ocelli on their front edges. Farther back than the bases of the pseudotentacles there is a round median group of numerous small cerebral ocelli. There are also two small light colored elevations.

Color of the central area very dark, almost black, with acute lobes of the same color extending toward the margin, which is translucent white, tinged with gray.

Length, about 30^{mm} ; breadth, 15^{mm}, but the form is very changeable.

Long Bird Island, under stones at low tide, April, 1901 (A. H. V.).

Pseudoceros aureolineata V., sp. nov.

PLATE V. FIGURE 6.

Body broadly elliptical, with thin undulated margins, but very changeable in form. Pseudotentacles broadly folded, bearing numerous small ocelli on the margin ; rows of similar ocelli extend along the whole margin of the body. A round cluster of small cerebral ocelli is situated anteriorly.

Color, above, in life, light purplish-brown or purplish fawn-color, irregularly spotted and specked with white, and with a median row of white spots or small blotches; toward the margin is a row of greenish spots, about at the edge of the brown area. The margin is translucent white, with a narrow, bright, light orange line at the edge; Under side anteriorly specked with flake-white.

Length, about 25^{mm}; breadth, 18 to 20^{mm}.

Long Bird Island, under stones just below low-tide, April 19, rare.

Stylochus Bermudensis V., sp. nov.

Body oblong-elliptical in life, with thin undulated edges. Tentaclês not long, rather far apart, situated about at the anterior fourth, conical and subacute in extension, short and blunt in partial contraction. Ocelli form a cluster in the base of each tentacle, and two or three marginal rows along the anterior part of the body, extending back past the middle.

Color, above, grayish green on a white ground color. The greenish color forms specks and blotches over the surface, with the white ground-color showing between them, and specked with flake-white. Just back of the tentacles there is a transverse row of three white spots, the median one the largest; under side white, mouth central.

Length, 18^{mm} in extension; breadth, 8 to 9^{mm}.

Harrington Sound, in shallow water, under corals, April 14, 1901.

The only specimen found was accidentally lost before a detailed figure had been made. The clusters of cerebral ocelli were not noted

Discocelis binoculata V., sp. nov.

PLATE V. FIGURES 3, 4.

A long, narrow, very active and changeable species, with thin and much undulated edges; anterior end generally obtusely rounded; posterior end tapered. Breadth to length often as 1 to 6 or 8, in extension.

The cerebral ocelli form two distinct round clusters, separated by a space greater than their diameters.

No marginal ocelli could be seen in one specimen, but in others there seemed to be a row of very small ones anteriorly.

Ground-color, pale flesh-color; light pink; pale yellowish-orange; or salmon, paler and translucent toward the margins; a row of about 12 orange-brown, ronndish spots along each side of the back,

about midway between the middle and the edges; outside and between these are numerous small specks of the same color. A median pale gastric streak extends from the ocelli to near the posterior end; it is usually bordered by a deeper colored, salmon or light orange band.

The stomach is long and narrow, occupying most of the length of the body behind the eyes. It gives off, mostly at right angles, a large number of narrow, lateral, dendritic branches The pharynx is not very long, subcentral, lobulated

Length in extension, up to 30 or 40^{mm}; breadth, 6 to 8^{mm}, but it often contracted to a shorter and broader form.

Under stones and dead corals, and in their crevices, at low-tide, Long Bird Island, April 10th and 20th. It is a very active species and creeps rapidly into holes and crevices, when disturbed.

This closely resembles, in color, general appearance, and in the cerebral eyes, the *Leptoplana Alcinoi* of the Bay of Naples, as figured by Lang (Polycladen, p. 486, pl ii, figs. 2 and 5). But our specimens appeared to have a row of small, anterior marginal ocelli, that are not present in the former.

Discocelis cyclops V, sp nov

PLATE V. FIGURE 1

Body usually much elongated, rather narrow, with thin, more or less undulated margins; anterior margin usually obtusely rounded; posterior end often tapered.

The two cerebral groups of ocelli are semicircular or semielliptical and very close together, so that they seem to form a single, rather conspicuous, rounded or elliptical eye, of larger size than usual in this group. Around the front margin there are also two or three rows of minute ocelli, which extend somewhat farther back than the cerebral groups.

Color of the body usually pale, translucent flesh-color or pale cream-color, but nearly white toward the margins; there is a rather wide median dorsal stripe of orange-brown, made up of minute round brown specks; similar specks are scattered over the whole surface, except near the edges, which are pale and translucent.

One specimen was, in general, reddish brown, due to the color of the dendritic gastric branches showing through. Another was nearly white, specked with orange. The dark median gastric stripe is often bordered with whitish.

The mouth is far forward, only a little behind the eyes.

The proboscis, which is often ejected in formalin solution, is large and clavate, four-lobed at the end, 12 to 14^{mm} long.

Length, up to 75 to 90^{mm} ; breadth, 10 to 15^{mm}, in extension ; it often contracts into much shorter and broader forms.

Harrington Sound, April 28th, on under side of dead corals, in shallow water. Castle Harbor, at Waterloo, low-tide, under stones, May 5th. The Scaur, under stones at low-tide, May.

This species is here referred to the genus *Discocelis* with some doubt, for its anatomy has not yet been sufficiently studied.

Trigonoporus microps V., sp. nov.

PLATE V. FIGURE 2.

Body thin, usually long and narrow, very extensile and changeable, the edges usually much undulated and very thin ; both ends may be subacute in extension. When fully extended the body is very narrow, the breadth being about one-sixth to one-eighth of the length.

Cerebral clusters of ocelli are lacking ; but numerous minute ocelli are scattered over the anterior dorsal region and along the anterior margins, becoming much more numerous and crowded into several rows close to the anterior end. The stomach is very long, extending through most of the length of the body, and it gives off very numerous, nearly transverse, lateral branches, which are subdivided into numerous dendritic branchlets.

Color of the body pale flesh-color or cream-color, the stomach and its branches showing through as rather darker pale ocher or brownish markings.

Length up to 50 or 60^{mm} ; breadth, in extension, 5 to 10^{mm}.

Castle Harbor and "The Scaur," under stones at low-tide ; May 1st to 5th.

This species closely resembles *T. cephalophthalma*, of the Gulf of Naples, (see Lang, Polycladen, p. 503, pl. ii, fig. 1), in form and in the arrangement of the ocelli. The latter, however, differs in color and, apparently, in the relative length of the median gastric cavity, which is about one-third the total length, yet when more fully studied they may prove to be identical. The internal reproductive organs of our species have not been studied, so that its generic position is not positively settled. I have placed it in *Trigonoporus* mainly because of its close resemblence to the Naples species, as to form of body and arrangement of the ocelli. In the latter the gastric streak is white, bordered and continued by orange-brown, otherwise the upper side is pale greenish gray.

Leptoplana lactoalba V.

These Trans , x, p 595, fig. 9, 1900.

Numerous specimens of this species were taken in 1901, many of which differ from the typical form, in being more or less tinged with flesh-color or pale yellowish brown. For this variety it may be convenient to have a special name. No differences, except in color, were noticed.

Var. **tincta,** nov

PLATE V FIGURE 8

Color of dorsal surface pale flesh-color, light salmon-color, or pale brownish yellow, due to numerous minute specks of pigmeht scattered in the tissues ; margins paler ; not very translucent. In this species the principal or most conspicuous cerebral ocelli form a pair of round clusters, well apart, on slightly elevated verrucæ. There is a simple row of two or three ocelli behind the round groups and a crowded, usually curved row in front. The stomach is not very long. No marginal ocelli were observed.

The form is very changeable and the species is very active, both in creeping and swimming.

Length up to 40 or 50^{mm} ; breadth, 18 to 25^{mm}.

Long Bird Island; Harrington Sound ; Castle Harbor, etc., under stones and corals. Common.

NEMERTINA.

Two or three additional species of Nemerteans were obtained in 1901, but they have not yet been fully studied.

The most interesting one was taken singly, two or three times, under stones, at low-tide. It was 150 to 175^{mm} long, and about 4 or 5^{mm} broad. It was somewhat flattened, except anteriorly. Its color was bright orange or scarlet ; no eyes were seen. It appeared to be related to *Polia* or *Eupolia*.

A species of *Lineus* was found in May by Mr. W. G. Van Name, among algæ, in a rather brackish pond near Bailey Bay. It was dark grayish brown on the upper side, paler beneath. Length, 75 to 100^{mm}. It occurred in considerable numbers, but it has not yet been studied with care.

The terrestrial nemertean (*Tetrastemma agricola* W. Suhm) was found common in April, near Hungry Bay, under stones and burrowing in the soil like an earthworm. They were from 2 to 4 inches

long, when extended, but they are said to grow to the length of 6 inches. They are quite active and can be kept alive for a long time in jars of moist earth. They occurred not only near the shore, but on the uplands where the soil was almost dry. The larger ones, in life, were dark grayish brown or slate-color along the back, but the smaller ones were nearly white.

ANTHOZOA.

ACTINARIA.

Cerianthus natans V., sp. nov.

PLATE IX. FIGURE 6.

Body in extension when swimming, rather long, bulbous or clavate near the base and enlarged rapidly close to the disk. Outer tentacles about 38, subequal, tapered, not very long, thin, length usually less than one-half the diameter of the disk; they appear to form two or three rows. Inner or oral tentacles much smaller and more slender, about 24, apparently forming two series, owing to their alternate positions.

Color of body orange-brown, tinged with yellow. Outer tentacles reddish brown, crossed by five or six bands of white; disk yellowish around bases of tentacles with a brown spot in front of the base of each; central part of disk bluish gray. Oral tentacles nearly white; mouth yellow, with lines of red running in from between the oral tentacles.

Length, in life 110^{mm}; diameter of column, 10 to 22^{mm}; of disk and tentacles, 45^{mm}, length of outer tentacles, about 10^{mm}.

Cony Island, floating free among algæ, March 26, 1901. (A. H. V.)

This species, when kept in confinement, could swim about actively by expelling water from the pore in the bulbous base. Only one example was taken. The tentacles are much shorter than usual in this group.

Epicystis osculifera (Lesueur) Ver.

Verrill, these Trans., x, p. 556, 1900.

PLATE VII. FIGURE 1.

Numerous specimens of this elegant actinian were obtained, some of them of large size. These render it still more probable that this form is distinct from *E. crucifera*, for it seems to have a characteristic pattern of colors.

The column is usually streaked with light red and pale pink, much as in *crucifera*, but the tentacles are longitudinally striped with green and white, one of the green stripes on the outside and two on the inside being dark green, while the lateral ones are light green; there is often an inner median streak or spot of yellow or orange; the bases are surrounded by dark green lines which run in on the disk as radial lines. The disk is generally lined or striped radially with green and white, variegated with orange and dark green spots. The lips are bright yellow, edged with green. The suckers are bright red and form short rows on the upper part.

There are usually only 6 or 12 of the primary and secondary tentacles that have more or less evident transverse raised ridges on the inner face of the tentacles. One of these usually occupies the inner end of each of the six infoldings of the disk.

It is sometimes 150^{mm} or more in diameter.

Hungry Bay; Castle Harbor; Harrington Sound. It lives between stones and in crevices of rocks and corals.

Lebrunia Danæ (D. & M.) Ver.

Verrill, Amer Journ. Sci, vii, p 46, fig 15, 1899. These Trans, x, p 555, pl lxvii, fig 8, pl lix, fig 1, 1900

PLATE VI FIGURE 1.

A number of large specimens of this species were obtained. They varied considerably in color, but none were distinctly green like those obtained in 1898.

The column, tentacles, and disk were generally light yellowish brown or fawn-color. The branchiæ were usually darker brown, often light umber-brown or chocolate-brown. The tentacles often had pale tips. The gills in extension were usually much longer than the tentacles; they were much branched arborescently, but they had few or no distinct rounded acrorhagi.

In this last character and in color they differed decidedly from the 1898 specimens, described and figured by me in 1900, and agreed nearly with *L. neglecta*, as described by McMurrich, from the Bahamas.

Phellia simplex V., sp. nov.

Column slender, elongated, often vermiform, changeable, covered with a closely adherent, brownish or dirty epidermis, except close to each end.

Tentacles about 24; inner ones slender, tapered but little, longer and larger than the outer ones, and equal to the diameter of the disk; outer ones small.

Color of disk usually buff, with white radii; tentacles translucent buff with a broad proximal patch of flake-white, beyond which there are two or three transverse bands of dark reddish brown. The lowest of these bands is W-shaped; the others are simple annulations.

Length, in life, 18 to 24^{mm}; diameter, 4 to 5^{mm}.

Long Bird Island, under stones at low-tide, April 19th; also at Waterloo, Castle Harbor.

This species has the aspect of an *Edwardsia*, but its basal disk is well developed.

Phellia rufa Ver.

These Trans., x, p. 557, pl. lxviii, fig. 2, 1900.

PLATE VI. FIGURE 5.

Numerous fine specimens of this species were found under stones in several localities, but it was particularly abundant and large at Waterloo, Castle Harbor, where the tidal streams from the adjacent caves flow out of the stony shores between tides.

At the latter locality specimens very much larger than the types were obtained. Some of these, in life, were 75 to 100^{mm} long, and 20 to 36^{mm} in diameter of body, with a correspondingly increased number of tentacles, which were often 96 to 120; the inner 12 are often erect and decidedly the largest The form of the body is very changeable.

In nearly all cases the column is a deep brownish red or dull salmon-brown, and the tough epidermis, which adheres very closely and extends nearly to the tentacles, is wrinkled in contraction. The disk and tentacles vary much in color, but are nearly always handsomely variegated with red, salmon-brown, or purplish brown, and flake-white. The tentacles are generally banded with flake-white and often they have two or three W-shaped bands of dark purplish brown or reddish brown. The disk has radial stripes or spots of the same brown colors, alternating with white, or the brown spots may be V-shaped.

Aiptasia tagetes (D. & M.) Andres.

PLATE VI. FIGURE 6.

Verrill, these Trans., x, p. 557, pl. lxvii, fig. 2, 1900.

This species was found very common in 1901, and numerous marked variations in its colors were observed.

The most prolific locality was the mangrove swamp at "Fairy Lands," where it occurred in great numbers, in April, attached to the fallen and floating mangrove leaves and twigs At this place numerous color-varieties occurred. Many of the specimens had one or both of the directive tentacles longer than the rest and partially or wholly flake-white; a band of white also crossed the disk in line with these tentacles. The other tentacles and disk were variously spotted and barred with flake-white; most commonly the ground-color of the tentacles was pale umber-brown or greenish, crossed by two to five unequal half bands and crescents of flake-white, on the inside.

One nearly albino specimen occurred at Waterloo. This had a pale flesh-colored, translucent column, with white specks above The long, slender, acute tentacles were pale yellowish, crossed on the inside, mostly near the middle, with 8–12 crescent-shaped, flake-white spots and intermediate specks; disk pale, with radial flake-white specks and spots.

Anemonia elegans V., sp nov.

PLATE VI. FIGURE 4

Column smooth, in ordinary expansion short, cylindrical, expanded at the base and summit; basal disk large, with undulated edges. Tentacles not retractile, numerous, in three or four rows, the inner ones much the longer, about equal to the diameter of the disk, slender, but little tapered, obtuse. Disk usually depressed with the mouth raised, but it is very changeable.

Color of column pale, brownish yellow or light fawn-color, sometimes light orange; tentacles light yellow or pale orange-yellow, with light purple or pink tips, edged below with whitish, and with a red basal line on each side and behind the base, and a triangular spot of whitish on the inner base in some cases; lips light red or scarlet; inside of mouth darker red, with two whitish gonidial grooves; disk yellowish, with narrow radial red or brown lines.

Height of column, in life, 12 to 15^{mm}; diameter, 10 to 12^{mm}; length of longest tentacles, 10 to 12^{mm}.

Cony Island, March 26, 1901 (A. H. V.).

Castle Harbor, under stones at low-tide, in May. Rare.

In color this resembles some varieties of *Condylactis passiflora*, but it has much more numerous and smaller tentacles than the young of that species of similar size.

Actinia melanaster V., sp. nov.

PLATE VI. FIGURES 2, 3.

Column in life rather short and broad, nearly cylindrical, expanded at base, but probably capable of much greater elongation. Tentacles numerous (about 76), retractile, very unequal, forming three or more rows, the inner 24 much the largest and longest, tapered, acute, arising well in from the edge of the disk; outer ones not half as long and much smaller. Two gonidial grooves; lips raised.

Color of column, in life, dark reddish brown; disk with a large, dark brown, stellate central area, with about 24 tapered radii, which run out between the bases of the inner tentacles, and with narrow, pale radial lines; outer portion of disk, between the brown radii, and inner bases of tentacles light yellow. Tentacles, except at base, dark reddish brown, with a central lighter reddish brown stripe. Mouth red, the lips edged with bluish white.

Specimens preserved in formalin have the following characters:

Tentacles about 96, long, tapered, acute, strongly sulcated in formalin preparations, length of inner ones about half the diameter of the disk. They are not very unequal; the inner 24 are, however, larger and longer than the rest and set in considerably from the border of the disk, and rather swollen near the base. They form five cycles or more, and seem to stand in three or four rows. More or less of the outer ones are imperfectly developed and short. Below the tentacles there is a distinct fosse and a marginal fold. On the latter there is a circle of about 24 larger acrorhagi, alternating with smaller ones. The larger ones are prominent, verruciform, and slightly lobulate on the outer or lower side, but apparently not perforated. The column below the margin, as preserved, is strongly vermiculate and sulcate, with about 96 sulci, alternately larger and smaller. The ridges between the sulci are crossed irregularly and closely by strong transverse and oblique or zigzag wrinkles, giving them a vermiculate appearance. No distinct suckers could be seen.

Mouth has two strong gonidial grooves and numerous lateral folds.

Diameter of disk as preserved, 25^{mm}; height of column, 20^{mm}; length of tentacles, $10–15^{mm}$.

Diameter of the column in life, 20 to 30^{mm}; its length, 40 to 60^{mm}; diameter of disk and tentacles, 40 to 50^{mm}.

Several specimens of this species were found at the entrance of Flagg's Inlet, deeply buried in crevices of the ledges, from which they could not be extracted except by cutting away the rock. (A. H. V.)

Condylactis passiflora (Duch. and Mich.).

Duchass. and Michelotti, Corall. Antilles, Supl., p. 31, pl. v, fig. 7. Verrill, these Trans., x, p. 555, 1900.

Some additional color-varieties of this very common species were observed this year. The most remarkable one was a large specimen, over a foot in diameter when expanded, found at "Sans Souci," in the interstices of a sea-wall. In this the column was light red, as usual, but the tentacles were pea-green with bright blue tips, instead of the usual pink, magenta, or violet tips. The tentacles, as seen expanded, were large and swollen, three to four inches long, with enlarged, obtuse or swollen tips.

Some pale or nearly albino specimens were also observed. The tips of the tentacles frequently lack the bright colors.

Palythoa grandiflora Ver.

Verrill, these Trans., x, p. 564, pl. lxviii, fig. 6, 1901.

PLATE VII. FIGURE 2.

Very extensive colonies of this species, several feet across, were found between tides, at Waterloo, in the course of the tidal streams. These were nearly uniform in color. The disk was generally orange-brown or dark yellowish brown, with paler radii and tentacles. A small portion of one of these groups was photographed while living and expanded, and this photograph is here reproduced.

GORGONIACEA.

Eunicea atra V., sp. nov.

PLATE IX. FIGURES 4, 5.

A black, rather large, much-branched species with the branches dichotomously divided, subparallel, often crooked, and very variable in size on the same specimen. The edges of the large calicles are only a little raised, and generally have a small, acute, angular lower lip, which may be obsolete. Most of the branches arise from near the base; many are rather long and cylindrical; others are more or less clavate, some are tapered and not more than two-thirds as large as the average. The calicles are variable in size and form; the larger ones are usually elliptical and rather close together.

Height, 12 to 16 inches (300 to 400^{mm}); breadth of the clusters of branches, about the same; diameter of branches, 10 to 12^{mm}; of calicles, 0.5 to 1.5^{mm}.

When living the color is black, and when first taken from the sea the water, mixed with mucus, that drips from the branches is almost ink-black and imparts a black stain to one's clothes and hands. This black coloring matter gives a black color to a large quantity of alcohol or formalin solution.

When dried the coral is black or dark umber. The polyps are yellowish brown, large and long in expansion. They contract rather slowly, but completely.

The spicules of the cœnenchyma (pl. ix) are mostly rather large and variable in form; the most characteristic are moderately stout, roughly warted spindles, sometimes with a side-lobe or branch; others are short thick spindles; with these are many others of smaller size.

This species was taken in about eight feet of water at "The Reach," where there is a rather strong tidal current.

The size and form of the calicles and slight development of their lower lip will distinguish this from the allied species.

Verrucella grandis V., sp. nov.

Plate IX. Figures 1, 2, 3.

This is a large, dichotomously branched, arborescent, yellow species, that grows at least five feet high.

The trunk is 12 to 16^{mm} in diameter, and the axis is round, very hard, calcareous, light brownish yellow. The cœnenchyma is rather thin, but hard, deep ocher-yellow, or inclining to orange-yellow. It forks repeatedly, so that there are numerous long and rather slender terminal branches, 12 to 18 inches long (300 to 450^{mm}) and 2 to 4^{mm} in diameter. The branches are somewhat flattened and occasionally squarish, with a sulcation along each side. The verrucæ, on the trunk and larger branches, are low and broadly rounded, about 1 to 1·5^{mm} in diameter, crowded in 3 or 4 rows on each side; on the branchlets they are mostly in two alternating rows on each side and are more elevated; their wider bases are in contact; summit rounded.

The spicules of the cœnenchyma (figure 3) are orange-colored, and small; the most abundant are short, strongly warted, double spindles; with these are many short forms, not much longer than broad, with papillose ends; several other smaller forms also occur.

A single large specimen, five feet high, was brought up from the depth of about 100 feet, outside the North Reefs, on a fisherman's hook, May, 1901.

POLYZOA.

The following additional species of bryozoa have been noticed in the collections made this year. The nomenclature followed is that of Smitt, (Florida Bryozoa, 1872). See also *Amathia Goodei* Ver., described last spring (Amer. Journ. Science, xi, p. 329, Apr., 1901), but not figured.

Idmonea Atlantica Forbes.

Smitt, Florida Bryozoa, p. 6, pl. ii, fig. 7.

Off the North Reefs, 16 fathoms.

Mollia patellaria (Moll, as *Eschara*).

Mollia patellaria Smitt, op. cit., p. 12, pl. ii, fig. 72.

Off the North Reefs, 16 fathoms.

Porina subsulcata Smitt.

Op. cit., p. 28, pl. vi, figs. 136–140.

With the preceding.

Porina plagiopora (Busk).

Lepralia plagiopora Busk, Crag Polyzoa, p. 44, pl. iv, fig. 5.
Porina plagiopora Smitt, op. cit., p. 30, pl. vi, figs. 134, 135.

With the preceding.

Anarthropora minuscula Smitt, 1867.

Op. cit., p. 31, pl. vi, fig. 141.

With the preceding.

Gemellipora glabra Smitt.

Op. cit., p. 37, pl. xi, figs. 207–210.

With the preceding.

Hippothoa mucronata Smitt.

Op. cit., p. 45, pl. viii, fig. 169.

On under side of corals, shallow water.

Lepralia edax Busk.

Cellepora edax Busk, Crag Polyzoa, p. 59, pl. ix, fig. 6, pl. xxii, fig. 3.
Lepralia edax Smitt, op. cit., p. 63, pl. xi, figs. 220–225.

On under side of corals, shallow water.

Cellepora avicularis.

Smitt, op. cit., p. 58, pl. ix, figs. 193–198.

Off North Reefs, on *Verrucella*, 16 fathoms.

ENTEROPNEUSTA.

Balanoglossus, sp.

A species of *Balanoglossus* was found this year burrowing in the sand-flats on the north side of Long Bird Island. It was about 150^{mm} in length. Its color was ocher-yellow to dull orange-brown. Its structure has not yet been studied with care. No species of this group has hitherto been reported from the Bermudas.

LEPTOCARDIA.

Branchiostoma Caribæum Sund. Lancelet.

Sundevall, Olfers, Vet. Akad. Forhandl., xii, 1853. Andrews, Synopsis Studies Biol. Lab., Johns Hopkins Univ., v, 4, p. 240, 1893. Jord. and Everm., Fishes Amer., i, p. 3, 1896.

Hitherto no locality for this *Amphioxus* has been known at Bermuda except on the west side of the inlet at the Flatts, where it was first discovered by Mr. Goode, in 1876. This year we dredged it on

Figure 4.—Lancelet (*Branchiostoma Caribæum*). ×1½.

a bottom of hard shell-sand and mud, in Castle Harbor, about one-half a mile north of Castle Island, in 15 to 20 feet of water. This is also one of the localities for *Strombus gigas.* Another similar locality, near Tucker's Island, in Great Sound, where *Strombus gigas* is found, would very likely also yield the lancelet.

FISHES.

Carcharinus platyodon (Poey). Shark.

Squalus platyodon Poey, Memorias, ii, p. 331, 1861.
Carcharias platyodon Jordan and Gilbert, Proc. U. S. Nat. Mus., p. 243, 1882.
Carcharinus platyodon Jord. and Ever., Fishes N. Amer., i, p. 39, 1896.

A dead specimen of this species, about four feet long, was found on the south beach near Tuckerstown, in April. It was badly decomposed and only some teeth could be preserved. From these the species has been identified by Mr. Samuel Garman. The color of the upper side was grayish blue; white below.

It has been recorded from Cuba, Texas, and the Gulf of Mexico, where it grows to a much larger size (10 to 15 feet long).

Pseudoscarus guacamaia (Cuv.). Green Parrot Fish.

Scarus guacamaia Cuv., Reg. Anim., ed. ii, vol. ii, p. 265, 1829.

Pseudoscarus guacamaia Jordan and Ever., Fishes North Amer , ii, p. 1657; iv, pl. 246, fig. 617. Evermann and Marsh, Fishes and Fisheries of Porto Rico, p. 245, fig. 68, 1900.

Many specimens of this species were found among the dead fishes on the beach of Long Bird Island, early in March, 1901. The turquois-blue teeth were conspicuous. No other parts could be saved. (Coll. A. H. V.)

Eques lanceolatus (Linné) Gunth. Guapena. Ribbon Fish

Chætodon lanceolatus Linné, Syst. Nat., ed. x, p. 277, 1758.

Eques balteatus Cuvier, Reg. Anim , ed 2, ii, pl. xxix, fig. 2, 1829.

Eques lanceolatus Gunther, Catal. Fishes, ii, p. 279, 1860. Jordan and Everm., Fishes N. Amer., ii, p. 1489, 1898.

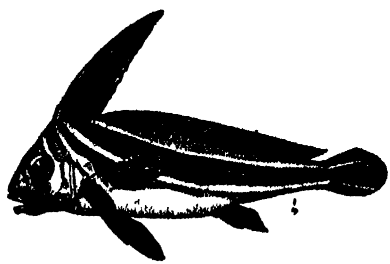


Figure 5.—Ribbon Fish. *Eques lanceolatus.* ½.

One specimen, retaining its characteristic color-marks, was found among the dead fishes cast on the beach near Hamilton early in March, 1901. (A. H. V.)

Eupomacentrus fuscus (Cuv. and Val.) J. and Ever. Maria Molly Brown Cock-eye Pilot.

Pomacentrus fuscus Cuv. and Val., Hist Nat Pois., v, p. 432, 1830.

Eupomacentrus fuscus Jord. and Everm., Fishes N. Amer., ii, p. 1552, 1898. Everm. and Marsh, Fishes of Porto Rico, p. 224, pl xxvii, colored, 1900.

Common in the mangrove swamp at Hungry Bay, April, 1901. (A. H. V.)

Scomberomorus maculatus (Mitch.). Spanish Mackerel. Carita.

Scomber maculatus Mitchell, Trans. Lit. and Phil. Soc. N. York, i, p. 426, 1815.

Scomberomorus maculatus Jordan and Ever., Fishes N. Am., i, p. 874, iv, pl. cxxxiv, fig. 368. Everm. and Marsh, Fishes Porto Rico, p. 128, pl vi (colored), 1900.

I was told by some of the inhabitants that this species is occasionally taken, but I saw no specimens.

Lycodontis funebris (Ranz.) J. and Ever.

Green Moray. Black Moray.

Gymnothorax funebris Ranzani, Nov. Com. Ac. Sci. Bonon., iv, p. 76, 1840, Brazil.

Lycodontis funebris J. and Ever., Fishes N. Amer., i, p. 396, 1896. Ever. and Marsh, op. cit., p. 77, 1900.

One specimen of this species was found among the dead fishes on the shore, early in March. I have seen two large living specimens in the New York Aquarium, brought from Bermuda by Prof. C. E. Bristol and party, in 1899.

REPTILES.

Anolis principalis (Linné). Blue-tailed Lizard. American Chameleon.

Anolis Carolinensis Dum. and Bibron.

PLATE I. FIGURE 5.

A single specimen of this small lizard was recently found in a jar containing a mixed lot of marine invertebrates collected by Mr. G. Brown Goode, at Bermuda, in 1876.

The only label was "Bermuda," in Mr. Goode's handwriting. As the specimens in the jar had never been assorted and all the other things were common Bermudian species, we must infer that the locality label is correct. But since there is no special note in respect to the lizard, it is quite possible that Mr. Goode knew that it had been carried to Bermuda, in captivity. It is possible, however, that he did not distinguish it from the young of the common Bermuda species and for that reason made no special note of it. No other example has occurred, so far as I know, but that proves very little, for no systematic search for reptiles has been made by any one in Bermuda.

Mr. Samuel Garman has compared this specimen with those taken in the southern United States and Cuba, and finds no differences whatever.

It is quite possible that it has recently been introduced into Bermuda, either accidentally or intentionally, and that it has become locally naturalized there, in small numbers, like several foreign birds. This lizard was first mentioned by me in the Amer. Journ. Sci., xi, p. 330, April, 1901.

BIRDS.

A list of 17 species of birds that have been recently added to the fauna has been published by Mr. A. H. Verrill.*

Of these, five species are recent successful introductions by commerce, either intentional or accidental. These are the American Goldfinch, the European Goldfinch, the European Tree-Sparrow, the Wheatear, and the Mockingbird, all of which are now resident and breed. The others (12) are rare migrants that probably do not breed there, though it is possible that the Red-billed Tropic Bird,

* Amer. Journ. Sci., xii, p. 64, for July (issued June 22d to 28th), 1901. He has also printed a more detailed article in "The Osprey," v, pp. 83–85, for June, 1901, with figures of the three following species and of the Tropic Bird, photographed from life. In these articles he has described the Bermuda Cardinal Bird and the Blue Bird as new subspecies, peculiar to Bermuda. The Cardinal Bird is named *Cardinalis cardinalis Somersii*; the Blue Bird, *Sialia sialis Bermudensis*; the Ground Dove, *Columbigallina passerina Bahamensis*.

Outram Bangs and Thos. S. Bradlee have also published a paper on the Birds of Bermuda in "The Auk" for July, 1901, pp. 249–257, in which new names are given to some of these birds and others.

They name the Ground Dove, *Columbigallina bermudiana*; the White-eyed Vireo, *Vireo bermudianus*; the Catbird, *Galeoscoptes bermudianus*; the Cardinal, *Cardinalis bermudianus*.

Mr. Verrill's article appears to have been published a few days earlier than the latter.

To me it seems quite useless to regard these very slightly differentiated forms as distinct "species." The differences noted, especially in the Ground Dove, Catbird, and Vireo, are trivial and scarcely sufficient to constitute *varieties*. To consider them as "subspecies" is certainly a sufficient strain on the much-stretched meaning of the term "subspecies." I should, therefore, call them mere local varieties, scarcely differentiated.

In respect to the Ground Dove, there are reasons for believing that it was introduced to Bermuda from the Bahamas, since the settlement of the islands, like many other things. None of the earlier writers mentioned it in the lists of birds that they gave. This would hardly have been the case had it been present, for it is exceedingly tame and familiar.

A. K. Fisher, Bird Lore, Oct., 1901, p. 178, states that the original *Motacilla sialis* Linné, ed. x, p. 187, was from Bermuda. This is not true. He gave it as from "Bermudis & America calidore." He also quotes Catesby, Hist. Carolina, etc., p. 47, pl. 47, 1731. Catesby says that he had seen it in "Carolina, Virginia, Maryland, and the Bermudas." But he states in his preface that his birds were mostly drawn in Carolina and Georgia, where he spent several years in drawing them. A few were drawn in the Bahamas, where he spent about a year, mostly on the fishes and plants. He does not say that he made *any* drawings in Bermuda, where he probably made a mere passing visit. The Bluebird does not occur in the Bahamas. His figure clearly represents the common North American variety.

of which a few were seen, may breed in small numbers with the common species. I may add that the European Starling has been taken several times, and may have become naturalized, but if so it is still rare.

MAMMALS.

Phoca vetulina ? (Linné). Common Harbor Seal

A seal, apparently of this species, has been taken at Bermuda. A skin is still preserved in the local collection made by the late Mr. Bartram, at St. Georges. It may, however, be the young of the West Indian seal.

Orca gladiator Gray=**Orca orca** (Linne). Killer.

Figure 6.—Killer

I was told by fishermen that this species is occasionally seen in Bermuda waters.

Grampus griseus Cuvier Grampus.

This species is also found in Bermuda waters, according to the local whalers.

Delphinus delphis (Linné). Dolphin.

This common oceanic dolphin also occurs in the waters around the Bermudas and should be considered as belonging to its fauna.

Probably several other related cetaceans occur, more or less frequently, in the vicinity of the islands.

While we were at Bermuda, in April, 1901, a small sperm whale, about 30 feet long, was captured and brought to St. Georges, where it was put on exhibition for a few days.

Sperm whales are not rare in the waters a few miles from Bermuda, but they are far less common than they were formerly.

The Biscay Right Whale (*Balæna cisarctica* Cope=*B. Biscayensis* Gervais) is now very rare in these waters, where it was once common.

EXPLANATION OF PLATES.

PLATE I.

Figure 1.—*Epialtus bituberculatus*, var. *Bermudensis* V , new var. Photog. from life, × 1⅓.

Figure 2 —*Platypodia spectabilis* (Herbst). Photog. from life. × 1½.

Figure 3.—*Paguristes insignis* (Saussure) Benedict=*Petrocheirus insignis*, vol. x, p 578.

Figure 4 —*Calcinus sulcatus* Edw. Photog. from life. Natural size.

Figure 5.—*Anolis principalis* (L). Dorsal view of head and neck of a Bermuda specimen. Photog. from nature. × 3.

Figures 6*a*, *b* —*Holothuria Rathbuni* Lamp. Photog. of two living specimens ½.

Figure 7.—The same. Tentacles expanded. Drawn from life. × 1½.

PLATE II.

Figure 1.—*Cyclois Bairdii* Stimp. Photog. from life. × 1½.

Figure 2.—The same. Front view. Photog. from life. About natural size.

Figure 3.—*Ophiolepis paucispina* M. and Tr. See vol. x, p. 585. Enlarged.

Figures 4*a*, 4*b*.—*Dolabrifera virens* V., sp. nov. Dorsal and ventral sides of the shell. Photog. from nature. Natural size.

Figures 5*a*, 5*b*.—The same. Shell of another specimen. Dorsal and ventral sides. Natural size.

Figures 6*a*, 6*b*.—*Dolabrifera ascifera*. Shell, dorsal and ventral sides. Photog from nature. Natural size.

PLATE III.

Figure 1.—*Lamellidoris miniata* V., sp. nov. Type. From life. × 3.

Figure 2.—*Dolabrifera ascifera*. Dorsal side. From life. ⅔.

Figure 3.—*Tethys* (*Aplysia*) *dactylomela* Rang. Dorsal side. Photog. from living specimen. ½.

Figure 4.—*Tethys* (*Aplysia*) *tarda* V., sp. nov. Type. From life. Natural size.

Figure 4*a*.—The same. Shell. Dorsal side. ⅔.

Figure 4*b*.—The same. Shell. Ventral side. ⅔.

Figure 5.—*Tethys* (*Aplysia*) *morio* V., sp. nov. Type. From life. ½.

Figure 5*a*.—The same. Shell. Dorsal side. ⅔.

Figure 6.—*Runcina inconspicua* V., sp. nov. Type. Dorsal side. From life × 16.

PLATE IV.

Figure 1.—*Elysia flava* V., sp nov. Type. Dorsal side From life. × 2½.

Figure 2.—*Elysia picta* V., sp nov. Type. Two specimens. From life. × 2½.

Figure 3.—*Elysia papillosa* V., sp. nov. Type. Side view. From life. × 3½.

Figure 4.—*Elysia subornata* Ver., sp. nov. Type. From nature. × 1⅔.

Figure 5.—*Elysia ornata* (Swain) Ver. Dorsal view, with side-flaps expanded. From life. ⅔ natural size.

Figure 6.—*Facelina Goslingii* V., sp. nov. Type. From life. ⅔.

Figure 7.—*Lamellidoris ? olivacea* Ver. Dorsal view. From life. × 3.

Figures 8*a*, *b*.—*Lamellidoris lactea* V., sp. nov. Type. Dorsal and side views. × 3.

Figure 9.—*Lamellidoris aureopunctata* V., sp. nov. Type. Side view. From life. × 3.

Figure 10.—*Pleurobranchopsis niveus* V., sp. nov. Type. Side view. From life. × 1⅔.

Figure 11.—*Dolabrifera virens* V., sp. nov. Type. Dorsal side. Photog. from a living specimen. ⅔.

Figure 12.—*Dolabrifera ascifera*. Dorsal side. Photog. from life. Natural size.

Plate V.

Figure 1.—*Discocelis cyclops* V., sp. nov. Type. Drawn from life. × 2.

Figure 2.—*Trigonoporus microps* V., sp. nov. Type. Drawn from life. × 2.

Figure 3.—*Discocelis binoculata* V., sp. nov. Type. Drawn from life. × 2.

Figure 4.—The same. Type. Drawn from life. × 2.

Figure 5.—*Pseudoceros bicolor* V., sp. nov. Type. Drawn from life. × 1⅔.

Figure 6.—*Pseudoceros aureolineata* V., sp. nov. Type. Drawn from life. × 1⅓

Figure 7.—*Thysanozoön griseum* V., sp. nov. Type. Drawn from life. Natural size

Figure 8.—*Leptoplana lactoalba* Ver., var. *tincta* V. Drawn from life. × 1¼.

Figure 9.—*Thalassema Baronii* Greef. Photog. from a colored drawing from life. Natural size

Figure 10.—*Golfingia elongata* Ver., vol. x, p. 670. Type. Photog. from nature. × 2.

Plate VI.

Figure 1.—*Lebrunia Danæ* (D. & M.) Ver. Side view. Photog. of a living specimen. ¼.

Figure 2.—*Actinia melanaster* V., sp. nov. Type. From life. Natural size.

Figure 3.—The same. Photog. of a living specimen. ⅔.

Figure 4.—*Anemonia elegans* V., sp. nov. Type. Specimen with the stomodæum protruded from the mouth. × 1¼.

Figure 5.—*Phellia rufa* Ver. From life. ¼

Figure 6.—*Aiptasia tagetes* (D. and M.) Andres. Photograph from life of two specimens attached to floating mangrove leaves. About ⅔ natural size.

Plate VII.

Figure 1.—*Epicystis osculifera* (Les.) Ver. Photog. from a living specimen. ½.

Figure 2.—*Palythoa grandiflora* Ver. Photog. of a living group in expansion. Natural size.

Plate VIII.

Figure 1.—*Albunea oxyophthalma* Miers. (See errata.) Photog. from a preserved specimen. ⅔.

Figure 2.—*Clibanarius Verrillii* Rathbun, 1901. Type. Photog. from nature. Left side. × 1⅓.

Figure 3.—The same. Another specimen. Dorsal. × 1⅓.

Figure 4.—*Cyamus fascicularis* V., sp. nov. Type. Photog. from nature. × 4.

Figure 5.—*Fallacia protochona* Schmarda. Photog. from a living specimen. ⅓.

Figure 6.—*Pectinaria regalis* Ver., sp. nov. Type, with tube. Photog. from a preserved specimen. Side view. ⅔.

Figure 7.—The same. Another specimen. ⅔.

Figures 8, 9.—*Catophragmus imbricatus* Sowerby. Two specimens. Photog. from nature. × 2⅓.

Plate IX.

Figure 1*a*.—*Verrucella grandis* V., sp. nov. Part of a terminal branch of the type. Front view. × 1½.

Figure 1*b*.—Part of a large branch. Front view. Photog. from nature. × 1½.

Figure 2.—The same. Part of one of the larger branches, seen edgewise. × 1½.

Figure 3.—The same. Spicules, various forms. Camera drawings. × 170.

Figure 4*a*, *b*.—*Eunicea atra* V., sp. nov. Type. Distal portions of two branches from one specimen. About ⅔ natural size.

Figure 5.—The same specimen. Group of spicules of various kinds. From camera drawings. × 17.

Figure 6.—*Cerianthus natans* V., sp. nov. Type. Side view. From life. ½.

Figure 7.—*Polycarpa multiphiala* Ver. One of the gonads. Much enlarged. See vol. x, p. 591.

Figure 8.—*Styela partita* (Stimp.), from the New England coast. See vol. x, p. 588. Gonads much enlarged.

[All the figures on the above plates are from photographs and drawings by Mr. A. Hyatt Verrill.]

ERRATA.

Page 17, line 1. For *Pericera subparallela*, read *Macrocœloma subparallelum* Miers.

Page 18, line 8 from bottom. For *Albunea oxycephala*, read *Albunea oxyophthalma* Miers.

Page 35, line 21. For *Blaumeria*, read *Blauneria*.

Page 35, line 22. The undetermined helicoid shell may be *Helicina lucida* (Drap.) of southern Europe.

III.—Variations and Nomenclature of Bermudian, West Indian and Brazilian Reef Corals, with notes on various Indo-Pacific Corals.

By A. E. Verrill.

The following observations on a few of the common reef corals of the West Indian fauna are some of the results of my studies of the reef corals continued during the past forty years. During this period I have examined nearly all of the important collections of corals in the United States, including the types of Dana and others.* I have also had opportunities to study, in life, and to collect large series of several of the species here discussed.

The nomenclature of many of the corals is still unsettled. This is due largely to the natural difficulties of the subject. Perhaps there is no other group in which it is more difficult to determine the truo characters of the genera and species and the actual limits of their variations. These difficulties cannot be overcome except by long and careful studies of large series of specimens of all ages and forms, grown under many diverse conditions. Good series of but few species can be found in most museums, even at the present time. Formerly, when most of the species were first described, series of specimens were generally unknown, and most of the species were described from a single specimen, o1 from very few, and these were often so beach-worn as to be nearly worthless for such a purpose.

In addition to these natural difficulties, the early literature is very unsatisfactory, for numerous species were often confounded under a single name, and a genus was often equivalent to one or several families, or even to the whole order.

In subdividing the old groups, later writers did not always take sufficient pains to follow the ordinary rules of zoölogical nomenclature, even in some cases when there could have been no reasonable doubt of the identity of the species and genera of the early writers.

* Among the collections studied by me are those of the Museum of Comparative Zoölogy, which I labelled and catalogued many years ago; those of the U. S. Nat. Museum, including most of Dana's types; those of the Museum of Yale University, also including many types of Dana and others; those of the American Museum, New York City; those of Professor Ward of Rochester, N. Y., now in the Field Columbian Museum of Chicago, of the Peabody Acad. Science, Salem, Mass.; of the Boston Society of Natural History, and many others.

The diagnoses of the Linnæan species are very poor and imperfect, and have led to much confusion. The longer descriptions of Pallas (1766) are excellent for that period.

In this article I have treated many of those genera and species that are among the most confused, but have not attempted to discuss all such cases, even among West Indian corals.

Mr. Vaughan (op. cit., 1901) has referred to the very poor character of the works of Duchassaing and Michelotti on the West Indian corals, which have led to much confusion and have very much retarded the elucidation of the synonymy. My own opinion of their works are entirely harmonious with Mr. Vaughan's. Fortunately Mr. Vaughan has been able to study the types of these authors that are in the Museum of Turin, and therefore he has been able to rectify many of their mistakes. In such cases I can but follow his determinations of their species, for I have not seen the types. I have, however, formerly studied a collection of corals sent to the Museum of Comparative Zoölogy by Duchassaing, as examples of their species. But I found that in very many cases the specimens sent did not at all resemble the species described under the same names, and concluded that Mr. Duchassaing himself was unable to identify their species

Mr. Vaughan has also recently studied some of the types of Ehrenberg and of Edwards and Haime, and has thus been able to correct several errors.

That the nomenclature adopted by Dana, Edwards and Haime, and other standard authors is not in accordance with the strict rules of priority in zoölogical nomenclature, has been well known to me and others for many years.* Personally, however, I should have preferred to have left the current names undisturbed, considering that long usage gives sanction to many slight irregularities of this kind, in the earlier writings, and I have hitherto avoided making many changes in current names for such strictly technical reasons.

* I do not share the opinion expressed by Mr. Vaughan (op. cit., p. 4) that M.-Edw. and Haime were influenced by unworthy motives, or autocratic ideas. Nor would I accuse them of changing names "arbitrarily" or "through ignorance." They did not hold precisely the same views of the rules of nomenclature that Mr. Vaughan follows, but they were in accord with the best usage of their period and country. Their great works are monuments of long, laborious, and faithful study, continued for over twelve years, and embracing all known corals. That they made a few mistakes is natural. We are all liable to do that. No one is infallible. I find it necessary to change 12 out of the 28 names of corals in Mr. Vaughan's revised list, p. 8.

But several recent writers, especially Mr. Gregory and Mr. Vaughan, have seen fit to make several radical innovations of this kind, changing the long current names of various genera and species to make them comply with more rigid modern rules of priority.

In a number of cases, however, they have been unfortunate in choosing or adopting the new names, so that their nomenclature has, in such instances, no more permanent foundations than the older ones they displaced, as will be shown later

Therefore, I have thought it desirable to look more deeply into this subject, and to go as nearly as possible to the root of the matter, and so have made several necessary changes that otherwise I should have chosen to have left untouched.

The changes in the application of the names *Mæandrina*, *Mæandra*, *Manicina*, *Madrepora*, *Acropora*, *Favites*, etc., are among the more notable instances of this kind. However, if they *must* be made, the sooner the better.

MADREPORARIA.

Family **Mæandridæ** Ver., nom nov

Mœandrinidæ Verrill, Comm Essex Inst., v, p 82, 1866

This family is intended to include all those meandriniform genera in which the zoöids remain more or less united in series, and when living do not in expansion raise the disk above the calicinal walls or collines, and the astreiform corals that increase by fission.

The coral may have the calicinal centers scarcely distinct, along the bottom of more or less elongated calicinal grooves, and the tentacles not in circles around the mouths (subfamily *Mæandrinæ*). Or they may be perfectly distinct and marked by the radiating arrangement of the septa, as well as by the aggregations of the columella, and the tentacles forming circles, (*Trachyphyllinæ*, *Favitinæ*)

The septa are rather finely dentate or serrulate and have a paliform lobe, with an emargination above it which marks the situation of the tentacles and border of the disk. The increase is chiefly by continuous incomplete fission, but in many cases exotheeal budding also occurs (see pp 68, 71). Most of the corals in this family are massive and some grow to great size. Nearly all are tropical reef-builders. The new name of the family is due to the necessary transfer of the name *Mœandrina* to the family *Eusmilidæ*, (see p. 66, note).

Subfamily **Mæandrinæ** Ver., nom. nov.

Mæandriform corals with indistinct calicinal centers and confluent zoöids. Tentacles mostly in parallel rows.

Mæandra Oken (emended.) Type, *M. labyrinthiformis* (L.). "Brain Corals."

Mycedium (*pars*) Browne, Civil and Nat. Hist. Jamaica, 1756; ed. 2, 1789, (*non* Oken).

Mæandra (*pars*) Oken, Lehrb. Naturg., p. 70, 1815.

Meandrina (*pars*) Lam., ii, p. 244, 1816, (not of 1801.)

Mæandra (*pars*) + *Manicina* (*pars*) Ehrenberg, Corall Roth. Meeres, pp. 99, 101, 1834.

Meandrina + *Manicina* (*pars*) Dana, Zoöph. Expl Exp., 1846.

Mæandrina + *Cœloria* + *Manicina* + *Diploria* + *Leptoria* (*pars*) Edw and Haime, Hist. Nat. Corall., ii, pp. 388–401, 1857

Platygyra + *Diploria* + *Manicina* Vaughan, Fossil Corals of Curacao, etc, Samml. Geol Reichs-Mus., Leiden, Ser. 2, ii, i, pp. 45, 48, 1901.

A study of large series of various species of the above so-called genera, during many years, has convinced me that they should all be reunited into one genus, which would thus correspond more nearly with the genus *Meandrina* Lam. (1816) and to *Meandrina* of Dana + *Manicina*, *pars*.

If it be necessary to restrict *Meandrina** (Lam., 1801) to the type *meandrites* (L.)=*pectinata* Lam., as claimed by Vaughan and others, the next generic name, in order of publication, would be *Mæandra* of Oken, 1815, in which the first species (*areola*=*Manicina areolata*, authors), as well as the second and fourth, belongs to this group. Ehrenberg, also, definitely adopted this name nearly in the sense used here. Vaughan arbitrarily chooses to assume that *M. meandrites* should be considered the type of *Mæandra*, and therefore places that name as a synonym of *Meandrina*. This is not logical and is contrary to his method of reasoning in other similar cases (e. g. *Favites* Link, on p. 22).

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* In establishing the genus *Meandrina* in 1801 (Syst An., p. 372) Lamarck named but one species, *M. pectinata*=*Madrepora meandrites* L.; Ellis and Sol., which may properly be the type, though he added many other species in 1816. M.-Edw. and Haime referred to these facts (Corall., ii, p. 389), but preferred to take for the type *M. filograna*, on the ground that *denticulated septa* was given by Lamarck (1801) as a character of the genus.

It is certainly a legitimate question for doubt, whether the characters given to a genus are not of more importance than the particular species cited as an example by the older writers, who did not usually give them as "types" in the modern sense.

As a matter of fact, one of the *meandrites* group was included by Oken in this genus by mere accident, it being erroneously referred to as a variety of a true *Mæandra* (*M. labyrinthiformis* (L.)= *Diploria*), while the four other species are of the *Diploria* and *Cœloria* groups. Moreover, he founded, in the same work, a new genus (*Pectinia*) for the *meandrites* group. This of itself would show that he did not intend to include *meandrites* in *Mæandra*. The fact that a copied figure of *meandrites* was given, as an example, has no special significance in this case, for the publisher of such general works, rather than the author, is in many cases responsible for the selection of the illustrations, which, as is well known, are often misleading.

It would be far more consistent and correct to take either the first species (*M. areola*=*areolata*), or else the second species mentioned, for the type of *Mæandra*. *Meandrites* had already been eliminated by Lamarck, as Vaughan himself admits, when he named it as the type of *Meandrina*, in 1801. But Ehrenberg (1834), in adopting the genus *Mæandra*, used it in nearly the sense now proposed, though he eliminated Oken's first species, referring it erroneously to his new genus *Manicina*, which, as understood by him, included *Plerogyra* and also *Colpophyllia* E. and H. (See note, p 85.) *Platygyra* was used by Ehrenberg as a subgenus of *Mæandra*. It included *Cœloria*, *Diploria*, and *Leptoria* E. and H., or the whole of his *Mæandra* except *Dendrogyra*. Therefore it is a synonym of *Mæandra* proper.

These eliminations of two of Oken's species clearly leave, as the real available type, *M. labyrinthiformis* (Linné)=*Diploria cerebriformis* E and H., which is *var. a.* of Oken's second species Therefore, should others still prefer to consider the latter the type of a special genus, on account of its usually double ridges, it should be called *Mæandra labyrinthiformis* (L.) Oken, but for those who do not thus restrict the Linnæan name it should be *Mæandra implicata* (Ellis and Sol.), or else *M. cerebriformis*. The forms *Stokesi* (E. and H.) and *geographica* Whitf., are mere growth-variations in the forms of the ridges and grooves.

The characters that have been used by authors to separate *Mæandrina* E. and H., *Diploria*, *Cœloria*, and *Manicina* are due only to slightly different modes of growth. These several forms do not show any structural differences, such as should characterize genera. Young examples of *Diploria* can scarcely be distinguished from *Manicina*, of similar age, even by the forms of the grooves

and ridges. Many large specimens of typical *Diploria* have both single and double ridges on their different parts, or even side by side, and the same is true of *Manicina.* The calicles may form long series, more or less winding, or they may be short, or even circumscribed, equally in *Diploria*, *Cœloria*, and *Mæandrina* E. and H., and these variations are often seen on a single specimen of either group. They all form radial infoldings or collines at the margins, when young. Resorption of parts of the collines is frequent.

In *Diploria* and *Manicina* E. and H, and probably in the other groups, the ends or other parts of the growing ridges often expand and give rise to new zoöids, and thus form new actinal grooves by extracalicinal budding. Therefore the intervening ridges in such cases are necessarily simple for a time. See pl. x, figs. 1–3.

The genus *Mæandra*, as restricted above, would include the following four common West Indian species, two of which are found at the Bermudas.*

Besides these there are two or three other rare West Indian species that are not well known. One of these (*M. varia*), which was described by Dana as *Astræa varia*, is remarkable for having a large part of its surface covered with circumscribed polygonal calicles like those of *Goniastræa*, to which genus it has usually been referred.

But simple or multiple circumscribed calicles also occur, more or less frequently, in all the other species, and they are often due to extracalicinal budding and subsequent division. There is a large specimen of *M. clivosa* in the Museum of Yale University which has a large part of its surface covered with simple angular calicles, while in other parts they are long and meandriniform, as usual. The same is true of some of the East Indian species of the *Cœloria*-group.

In the Indo-Pacific region, including the Red Sea,† there are a considerable number of nominal species of *Mæandra*, most of which have been referred to *Cœloria* and *Leptoria.*

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* Nelson (Trans. Geol. Soc. London, v, p. 112) records the occurrence of *M. areolata* as a fossil in the older beach rock. Probably his specimens are the same that Mr. Vaughan has recently identified as *Mycetophyllia Lamarckana* (in coll. Geol. Soc.). Neither of these species has been found living at the Bermudas, but the older "beach rock" there contains also several West Indian shells that no longer exist in the Bermudas, indicating a period of warmer climate than at present. This rock may be post-glacial in age. It is overlaid by several forest or red-clay beds with much æolian limestone interstratified.

† See Klunzinger, C. B., Die Korallthiere des Rothen Meeres. Madreporaria. Berlin, 1879. In this excellent work there are good descriptions and photographic figures of five species and four varieties of *Cœloria* and of one species of *Leptoria.*

Among those of the section *Cœloria* are the following:

M. dædalea (Ellis). E. Indies.

M. dœdalina (D.).=*Astræa deformis, pars*, Dana, (*non* Lam.) Fiji Is.

M. spongiosa (Dana). West Indies (?). Pl. xii, fig. 3.

M. pachychila (Ehr.= *C. labyrinthiformis* E. & H., *non* Linné.

M. lamellina (Ehr., p. 99)+*M. leptochila*, Ehr.,= *C. Bottai* and *C. Forskælana* E. and H. = *C. Arabica* Klz. Red Sea.

M. laticollis E. and H., (Corall., ii, p. 415, pl. D4, fig. 4, as *Cœloria*).

M. Sinensis (E. and H., Corall., ii, p. 416, as *Cœloria*). China.

M. stricta (E. and H., op. cit., p. 417). E. Indies.

M. astræiformis (E. and H , op. cit., p. 417). Red Sea.

M. Esperi (E. and H., op. cit., p. 417). Red Sea.

M. leptoticha (Klz., as *Cœloria*). Red Sea.

M. laxa Ver., sp. nov. This has broad, distant, and very thin septa, with the edges sparingly and very irregularly toothed, and with the summits broad and rounded or subtruncate. Walls very thin. Valleys deep, mostly sinuous. Columella but little developed. Depth of calicinal valleys, about 7^{mm}; width about 5 to 8^{mm}. Kingsmills Islands.

M. elegans, M. deltoides, M. Australiensis (all Rehb.), Australia.

The following have been referred to *Leptoria* by Edw. and Haime, on account of the somewhat lamellose columella:*

M. gracilis (Dana). Fiji Is.; *M. tenuis* (Dana). Tonga Is.

The following are, apparently, more closely related to the typical West Indian species:

M. rustica (Dana). Wakes Island.

M. valida (Dana). Locality unknown.

M. rudis Verrill=*M. phrygia* Dana, *non* Ellis and Sol.

M. delicatula (Ortman, 1888). Samoa.

The following species were referred to *Diploria*:—

M. crassior (E. and H., Corall., ii, p. 403). China Sea.

M. spinulosa (E. and H., op. cit., p. 404). China Sea.

He proposes *C. Arabica* Klz. to include *M. leptochila* and *M. lamellina* Ehr. + *C. Forskælana, C. Bottai*, and *C. subdentata* Edw. and Haime, as varieties. This shows that the Red Sea species are quite as variable as the West Indian. However, it seems to me undesirable to give a new name (*Arabica*) to this revised and extended species. It would be better to extend the sense of *M. lamellina* (Ehr.) so as to include all these forms.

* The structure of the columella is not essentially different in the two following species (types examined) from that of typical *Mœandra*, especially that of *labyrinthiformis* when the latter is poorly developed. It is not a continuous plate, but consists of small, irregular, interrupted laminæ.

Mæandra labyrinthiformis (L.) V. Brain Stone. Brain Coral.

Madrepora labyrinthiformis (*pars*) Linné, Syst. Nat., ed. x, p. 794, 1758.

Madrepora meandrites, var. γ, Pallas, Elench. Zoöph., p. 292, 293, 1766.

Madrepora implicata Ellis and Solander, p. 164, 1786. Gmelin, op. cit., p. 3768.

Madrepora labyrinthiformis Esper, Pflanzenth., p. 74, pl iii, 1789.

Mæandra meandrites (*pars*), including as var. *a*, *labyrinthiformis* (Linné), Oken, Lehrb Naturg Zoöl., i, p. 70, 1815.

Meandrina cerebriformis Lamarck, Hist. Nat. Anim. s. Vert., p 246, 1816.

Mæandra (*Platygyra*) *cerebriformis*, vars. *a* and *b*, Ehrenberg, Corall. Rothen Meeres, Abhandl. Kgl. Akad. Wiss. Berl, p. 324 [100], 1834

Meandrina cerebriformis, p. 263, pl. xiv, fig 2; + *Meandrina truncata*, p. 264, pl. xiv, figs. 1, 1*a*, Dana, Zoöph. U. States Expl. Exped, 1846.

Diploria cerebriformis Milne-Edwards and Haime, Compt. rend., xxvii, p 493, 1848.

Diploria cerebriformis, + *Diploria Stokesi*, pl. D4, fig. 3, + *Diploria truncata* Milne-Edwards and Haime, Hist Nat. Corall., ii, pp 402, 403, 405, 1857.

? *Mæandrina labyrinthiformis* Pourtalès, Florida Reefs, Corals, pl ix, figs. 10–12, 1880.

Diploria cerebriformis Pourtalès, Ill. Cat. Mus Comp. Zoöl, No. iv, Mem ii, p. 75, 1871; Verrill, these Trans., x, p. 552, 1900.

Diploria geographica Whitfield, Bull. Amer. Mus., N. York, xiv, p 228, pl. xxxiii, xxxiv, 1901. (Types examined.)

Diploria labyrinthiformis Vaughan, Samml. Geol. Reichs-Mus., ii, p. 45, 1901 (*non Cœloria labyrinthiformis* Edw. and Haime).

PLATE X. FIGURES 1–8.

This species can usually be distinguished from the allied forms by the generally double ridges between the actinal grooves and by the presence on these ridges of a more or less wide intermural furrow, but the furrow may be lacking or obsolete, and the wall may be simple and solid on parts of many specimens.

While living, the color of the soft parts is usually dull orange-yellow, but it varies from light ocher-yellow to brownish orange. The structure and appearance of the tentacles, mouth, and disk are like those of *M. cerebrum* and *M. clivosa*.

This is the most abundant of the reef-corals at the Bermudas. When it grows under very favorable conditions it forms large, evenly hemispherical or dome-shaped masses, which are sometimes 5 or 6 feet in diameter, and nearly as high. Perfect specimens of this form, from 8 inches to 2 feet in diameter, are much sought after by collectors, and are, therefore, common in museums. Much larger numbers of specimens on the reefs take on irregular, broad, thick encrusting forms, due to less favorable conditions, injuries, and especially to crowding and coalescence.

A very extensive series of this species was collected, in 1898 and 1901, in order to study its variations. Over 800 specimens of all sizes from less than half an inch up to over five feet in diameter were studied by me.

The variations are very great in several directions:—as in the modes of growth; breadth and depth of the actinal grooves; and especially in the breadth of the intervening ridges and of the intermural or exothecal groove at their summits. The length, direction, and arrangement of the grooves and ridges vary in every possible way, often presenting the most diverse arrangements on different parts of a single large specimen, especially if it has grown in a more or less crowded or restricted position.

These common variations include those forms that have been named *Diploria Stokesi* Edw. and Haime, but which differ in no way from the typical forms, except in having unusually wide ridges, surmounted by a deep intermural groove, which often expands, especially at the end of a ridge, to the breadth of 10 to 15^{mm}.

Extracalicinal budding frequently occurs in these wide intermural grooves. In life, many of these grooves show a distinct mouth, or a series of mouths, with rows of tentacles, before any marked changes occur in the underlying coral. But soon the bottom of the groove receives deposits of columellar tissues, and then paliform lobes and septa rapidly appear. Thus after a short period of growth, these grooves become true actinal grooves formed over the exothecal tissues of the walls, by true budding. They often become as deep and well formed as the other furrows before they break through, at one or more places, and thus become connected with the older grooves. Some of them, both long series and single calicles, may remain isolated for a long time in some specimens.

As a matter of course, actinal grooves formed in this way must be separated for some time by simple walls only. This accounts for many of the cases where simple ridges are found mixed with double ones on the same specimen (pl. x, fig. 1). A single ridge may also, on this account, be double for a part of its length and single in other parts, or it may divide into two simple ones, in certain places.*

* Probably some of the confusion in respect to the synonymy of this species is due to the fact that this mode of growth has not been recognized by authors, and therefore specimens of this species with simple ridges have been referred to different species and to a different genus (*Mæandrina*), for such specimens have all the characters of *Mæandrina*, as contrasted with *Diploria*. (See p. 67.)

It is not improbable that the figures of *M. labyrinthiformis* Pourtalès (op. cit., Florida Reefs, pl. ix, figs. 10–12, 1880) were drawn from a specimen of this kind

This mode of increase, by exotheeal budding, seems to occur most freely in young specimens 2 to 3 inches in diameter, though not exclusively so. In such specimens the ridges are often all or nearly all broad and deeply grooved, or just ready to divide (plate x, figure 3). Others, scarcely larger, may be found in which all or nearly all the ridges are narrow and single, without grooves, the divisions having already taken place (pl. x, fig. 2). Specimens in both these stages, and in various intermediate conditions, were collected by me in Bermuda, both in 1898 and 1901.

The stage in which broad and deeply grooved ridges occur has been named as a distinct species (*Diploria Stokesi*) by Edwards and Haime. Some later writers have called it a "young stage"; others have called it a *variety*. It appears, from the facts just stated, that is is only a phase of growth, which may occur at various stages of development. *M. truncata* Dana seems to have been based on a phase following the division of the ridges and before the new grooves had developed on their summits. Such specimens are not rare. See pl. x, fig. 2.

Large specimens occur in which one part will show the *Stokesi* arrangement, while another part will be of the typical form; and still other parts will present simple or nearly simple solid ridges of the *truncata* phase. See pl. x, fig. 1.

Many oblong specimens show, especially on the sides, many long and nearly parallel, subradial, or nearly transverse ridges and grooves, while on other parts they present the ordinary convoluted arrangement.

The gyri are often in places more or less angular or zigzag, especially on the median or more crowded portions, thus showing that the form recently described and figured by Whitfield as *D. geographica** is only a form of growth, not of varietal value.

Many of the larger hemispherical and oblong examples consist of two, three, or more originally separate masses that have come in contact by growth and crowding, and have then grafted themselves together completely. The planes of union are usually shown only by a thin line of epitheeal tissue. Some of these double specimens are as evenly and regularly hemispherical as the simple ones.

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and not from *M. cerebrum*, as Vaughan supposed. The types from which the original plates of that Report were drawn were not separately preserved nor in any way indicated by labels. While I had charge of the coral-collections of the Mus. of Comp. Zoölogy (1860–1864), I tried in vain to identify the specimens that had previously been figured on those plates, which were then unpublished. Therefore any question of synonymy must be settled by the plates themselves. Fortunately they are very accurate.

* Bull. Amer. Mus., xiv, p. 223, 1901.

The characters of the septa and costæ are also variable, though more reliable than the form of the ridges. The septa are not very crowded, though more so than in *M. cerebrum*. Smaller, thin ones alternate with the larger and usually extend down below the paliform lobe. The larger septa are rather broad, generally with the inner edge perpendicular, and often sometimes broader above, usually with the summit broadly rounded and continued into prominent costæ which have rather regular conical or spiniform serrations on their edges. The paliform lobe is generally well developed and roughly serrulate; the inner edge of the septa bears numerous, small, close, irregular, elongated teeth, many of which are rough or forked at the tip; those toward the summit are longer, directed strongly obliquely upward and frequently incurved; those on the rounded summit are usually more regular and divergent. The sides of the larger septa are covered with rather few and scattered conical grains,—much fewer and smaller than in *M cerebrum*.

The columella is variable, but usually well developed, composed of curled lamellose processes, and thickened at the centers. Sometimes it is larger and nearly solid or subvesicular.

In transverse section the walls vary in breadth, but are usually thick and solid. In those specimens that have thin and simple walls at the surface, a section made an inch or so from the surface usually shows most of the walls as thick as usual (about 3 to 5^{mm}). The septa in section are thin and sparingly spinulose latérally, quite unlike those of *M. cerebrum* in similar sections.

The actinal grooves vary considerably in breadth and depth, but they are always decidedly narrower and shallower than those of typical *M. cerebrum*, and have a more square-cut appearance. The breadth from wall to wall, at top, is generally 5 to 10^{mm}; of the open valley, septal edge to septal edge, 4 to 6^{mm}; depth, mostly 4 to 6^{mm}. Number of septa to a centimeter, usually 14 to 16. One variety (*compacta*) has unusually shallow and narrow valleys (3–5^{mm} wide), with crowded septa.

This species is the largest and most important of the Bermudian reef corals. It occurs abundantly on the inner reefs of Great Sound, Castle Harbor, etc., often close to the shores and in water only two feet deep at low-tide, and mostly in less than twenty feet. It is still more abundant on the outer reefs. It does not occur in Harrington Sound, probably owing to a slightly diminished salinity of the water, due to its nearly land-locked condition. It may form masses 6 to 8 feet in diameter and height.

It is found on the Florida reefs and throughout the West Indies.

Mæandra cerebrum (Ellis and Sol.) V. Brain Coral. Brain Stone.

Madrepora cerebrum Ellis and Sol., Nat. Hist. Zoöph., p. 163, 1786. Gmelin, in Linné, Syst Nat., ed. xiii, vi, p. 3768, 1798.

Madrepora labyrinthica Ellis and Solander, Nat. Hist. Zoöph., p. 160, pl. xlvi, figs. 3, 4, 1786 (not of Pallas, which is *M. meandrites* Linné, ed. x.)

Meandrina labyrinthica (*pars*) Lamarck, Hist. Nat Anim. sans Vert., ii, p 246, 1816 (non *Mad. labyrinthica* Pallas).

Meandrina sinuosa LeSueur, Mem. Mus. d'Hist. Nat. Paris, vi, p 278, pl. xv, fig. 4, and ? varieties *viridis*, p. 279, pl. xv, fig. 5; ? *appressa*, p. 280, pl. xv, fig. 6; ? *rubra*, p. 280, pl. xv, fig. 7; ? *vinacola*, p. 280, pl. xv, fig. 8, 1820 (*non Madrepora sinuosa* Ell. and Sol. = *Mussa* or *Isophyllia*; *nec Meandrina sinuosa* Quoy and Gaimard).

?? *Meandrina dedalea* Les., op cit., p. 281, pl. xvi, fig. 9, 1820.

M. labyrinthica Les., op. cit., pl. xvi, fig. 10, 1820.

Meandrina labyrinthica Lamouroux, Exp. Meth. Gen. Polyp, p. 54, pl. xlvi, figs. 3, 4 (reprint from plate of Ellis and Solander), 1821 (*non* Pallas).

Mæandra (*Platygyra*) *labyrinthica* (*pars*) Ehrenberg, Cor. Rothen Meeres, Abh. k. Akad. Wiss. Berl. for 1832, p. 323 [99], 1834. (Includes 5 species, mostly of *Cœloria*, t. Vaughan, from types.)

Meandrina labyrinthica, p. 256, pl. xiv, fig. 1; + *M. strigosa*, p. 257, pl xiv, fig. 4*a*, Dana, Zoöph. U. States Expl. Exp., 1840.

Mœandrina heterogyra, p. 392; + *M. sinuosissima*; + *M. serrata*, p. 393; + *M. crassa*, p. 394, + *Cœloria strigosa*, p. 418, Milne-Edwards and Haime, Hist. Nat. Corall., t. ii, 1857 (teste Vaughan, from types). See also *M. sinuosa* Les. and varieties, described on p. 389, foot note.

Leptoria fragilis Duchassaing and Michelotti, Mem. Corall. Ant., p. 351, 1861 (teste Vaughan, from type).

Mœandrina strigosa Pourtalès, Flor. Reefs, Corals, Mem. Mus. Comp. Zoöl., vii, pl. ix, figs. 6–9, 1880.

Mœandrina strigosa, pp. 10, 92; + *M. sinuosissima*, pp. 10, 91; + *M. labyrinthica*, pp. 10, 12, 91; + ? *M. sinuosa*, p. 12, Quelch, Reef Corals, Chall. Exp., vol. xvi, 1886.

Mœandrina filograna (*pars*) Gregory, op. cit., p. 265 (*non* Esper).

Platygyra viridis Vaughan, Samml. Geol. Reichs-Mus., ii, p. 51, 1901 (after var. *viridis* Les.)

Platygyra sinuosa Vaughan, op. cit., p. 56, 1901.

Mœandrina labyrinthica Whitfield, Bull. Amer. Mus. Nat. Hist., N. York, xiv, p. 221, pl. xxxi, xxxii, 1901. (Abnormal, type studied.)

PLATE X. FIGURE 4. PLATE XII. FIGURE 4. PLATE XIV. FIGURES 4, 5.

This species usually forms evenly convex, thick, encrusting masses, or when well grown, large even hemispheres, sometimes a yard or more in diameter, with intricately convoluted gyri. Its actinal grooves are usually wider and more open than in the preceding species, while the mural ridges are generally high, narrow, solid, and rather thin in sections, and they usually appear acute at the crest, owing partly to the fact that the septa are generally narrowed

toward the summit; but also because the wall itself is generally (but not always) reduced to a thin solid lamina, which, as seen from above, runs as a zigzag line from septum to septum. The larger septa usually alternate with small very thin ones, most of which do not extend half way to the paliform lobes, thus leaving wide interseptal spaces below. The large septa are usually thin and rather narrow, with the inner edge rapidly sloping or nearly perpendicular to the well marked paliform lobe, so that the actinal grooves are generally deep and often more than twice as wide as the ridges, the width decreasing gradually to the level of the paliform lobes. The summits of the septa are only slightly prominent above the thin wall, and may be evenly but obtusely rounded, or they may have a gothic form, narrowing rather abruptly, giving a rather acute form to the ridges. Their inner edges are strongly and usually rather regularly serrulate, the teeth are often angular and sharp like saw-teeth, but are frequently more elongated and uneven, some of them having minutely forked or lacerate tips; the teeth are directed obliquely upward, but are seldom incurved, as is so often the case in the preceding species. The paliform lobes are a little thickened and roughly serrulate on the sides and edges. The sides of the septa are almost always very roughly spinulose or hispid, being thickly covered with small, acute, spiniform grains, much more numerous and conspicuous than in the allied species. This is usually a good diagnostic character, and is available even in worn specimens, for these lateral septal spinules are conspicuous on the thin septa in transverse sections. The columella varies considerably; it is usually well developed and composed of numerous, small, thin, contorted laminæ, sharply spinulose laterally, and united into a nearly continuous but uneven series, with thickenings at irregular intervals. In some cases the columella is much less developed and composed of few laminæ. The gyri in large specimens are long and intricately convoluted in every direction, but in smaller examples they may be more or less radial, or parallel for long distances, especially on the sides. In some specimens, though rarely, short gyri occur, and in some instances isolated, round or elliptical, *Astræa*-like calicles may be found, due to intermural budding, but these are much less common than in *labyrinthiformis* and *clivosa*. Pl. xiv, fig. 4. Double mural ridges are rarely seen, but they sometimes occur, especially near the margins of the smaller specimens.

In sections the coral is rather cellular; the walls are relative thin and nearly solid, being seldom more than 1·5 to 2^{mm} thick, while the

septa are alternately thicker and thinner, and show numerous lateral spinules, as mentioned above. See pl. x, fig. 4.

This species can usually be easily recognized by its evenly convex surface and the long convoluted simple, often gothic ridges, with the crest of the wall, thin, solid, and often in a zigzag line; by its rather open grooves, generally wider than the ridges, and usually showing rather open interseptal spaces and thin unequal septa; and especially by the strongly spinulose lateral surfaces of the septa.

The width and depth of the actinal grooves varies considerably, but is almost always greater than in *labyrinthiformis*. The breadth from wall to wall is generally 8 to 14^{mm}, rarely as little as 6^{mm}; open space between septal edges, near summit, mostly 6 to 10^{mm}; depth of grooves mostly 6 to 10^{mm}, usually about 8^{mm}. Number of septa to a centimeter, usually about 24 to 28, when the smaller ones are developed.

The color of this species, in life, so far as observed by me at the Bermudas, is dull yellow, ocher-yellow, or brownish yellow. It appears not to have the orange-yellow color, so general in *labyrinthiformis*. In the Bahamas it is more variable in color.

I think it very improbable that all the various color-varieties, named by Lesueur from the color alone, pertain to this species. But in any case they cannot be determined from color alone, for the color of such corals is variable and uncertain. Therefore *M. viridis* of Lesueur rests on no valid characters.

This species is not abundant in the Bermudas. It is sometimes, though rather rarely, found on the inner reefs, associated with the preceding species, but it occurs more commonly on the extreme outer reefs. Most of the larger specimens that I have seen were from the vicinity of the North Rocks, where it becomes one to two feet or more in diameter. It is common in the West Indies and on the Florida Reefs, where it grows to a large size. I have seen specimens over a yard across.

At least two forms of simple ridged *Mæandræ* occur on the outer reefs of the Bermudas. Whether they represent more than varieties of the above species may be doubtful, for no one has yet obtained a sufficiently large series of them for study. Those that I have seen appear to me to belong to two species, for they differ decidedly as to the form and denticulation of the septa and in other ways. The more common form seems to be the abundant West Indian and Florida species, named above.

I am not prepared to admit that all the described West Indian

forms, referred to this species by Vaughan, really belong to one species. It is certain that too many species of this group have been admitted by Edw and Haime; Duch. and Michel.; and others. But Gregory has gone to the opposite extreme in uniting *M. clivosa* =*filograna*, etc., to this species, from which it differs very plainly. The latter does not occur at the Bermudas.

Much diversity of opinion has prevailed as to the correct name for this species, as shown by the above synonymy. Apparently none of the names in use for members of this genus in works previous to Lesueur's memoir are available, except *M. cerebrum* Ellis and Solander, which was evidently based on the most common form of this species. Their description, though brief, is characteristic, and they also give the vernacular name, "Brainstone," which is still in use in the Bahamas and the Bermudas. But it was also undoubtedly included by Linné, Pallas, Ellis and Solander, Esper, and other writers of the 18th century under several other names that now apply more strictly to different species.

It appears to me that *M. sinuosa* of Lesueur could be retained for this species, were it the first available name that clearly applies to it. Vaughan rejects it because Lesueur referred *doubtfully* to the *Madrepora sinuosa* of Ellis and Solander (probably from memory alone). But the latter belongs to a widely different genus, and has no particular resemblance to this species, so that there can be no danger of confusion in this case. Lesueur described his species under a different genus, as if it were new. His erroneous and useless synonym, given with doubt, should not invalidate his name.

Moreover, Vaughan adopts *viridis*, the name of one of the color-varieties described by Lesueur, for the species. There can be no certainty that this variety pertains to *M. sinuosa*, for Lesueur gave to it no characters except the green color. It is well known that the green color, so frequent in coral animals, is generally due to a parasitic, unicellular, vegetable organism and it may occur in almost any species of reef corals, so that one could never be certain of the difference or identity of two allied corals having this color, even in the same locality, without studying the hard parts. On this account also, the name *viridis* should not be adopted for this species In this case the name *viridis* is not connected directly with any specific characters and therefore has no claims for recognition. The same remark would apply to the other "varieties" of Lesueur. They are not recognizably characterized. The next distinctive name, not based on color, appears to be *strigosa* Dana, 1846.

I have seen the type of Dana's *strigosa* and consider it this species from personal study of it. The figures published by Pourtalès (op. cit., 1880) are excellent.

Whitfield (op. cit., 1901*) has described and figured an interesting abnormal specimen of this species from the Bahamas, which he thought a case of union between a *Ctenophyllia* and *Mæandrina*. But the central part, which he called *Ctenophyllia*, is not that genus. It has serrate septa and is only a variation of this *Mæandra*, in which the ridges and valleys have become unusually wide, the latter varying from about 12 to 15^{mm}. Similar cases are not rare.

Mæandra clivosa (Ellis and Sol.) Ver.

Madrepora clivosa Ellis and Solander, Nat. Hist. Zoöph., p. 163, 1786.

Madrepora filograna Esper, Pflanzenth., p. 189, pl. xxii, figs. 1, 2, 1789.

Madrepora clivosa Gmelin, Linné, Syst. Nat., ed. xiii, p. 3768, 1790.

Meandrina filograna Lamarck, Hist. Nat. An. s. Vert., t. ii, p. 248, 1816.

Meandrina interrupta, p. 258, pl. xiv, fig. 18; *M. filograna*, p. 262; *M. mammosa*, pl. xiv, figs. 10, 10a; Dana, Zoöph. U. States Expl. Exp., 1846.

Meandrina filograna; M. grandilobata; M. superficialis Milne Edwards and Haime, Ann Sci. Nat., ser. iii, xi, pp. 280, 281, 283, 1849, (t. Vaughan).

Mæandrina filograna; M. grandilobata; M. superficialis and *M. ? mammosa*, p. 396, Milne-Edwards and Haime, Hist. Nat. Corall., ii, pp. 390, 391, 396, 1857, (t. Vaughan from types).

Mæandrina clivosa Verrill, Bull. Mus. Comp. Zoöl., i, No. 3, p. 48, 1864; Proceed. Bost. Soc. Nat. Hist., x, p. 323, 1865.

Mæandrina superficialis; M. interrupta; M. grandiloba; and *M. filograna* Duchassaing and Michelotti, Mem. Corall. Ant., p. 74, 1860, (t. Vaughan, from types).

Mæandrina clivosa Pourtalès, Ill. Cat. No. iv, Mem. Mus. Comp. Zoöl., ii, p. 74, 1871.

Mæandrina clivosa Pourtalès, Florida Reefs, Corals, Mem. Mus. Comp. Zoöl., vii, No. 1, pl. ix, figs. 1–5, 1880.

Mæandrina filograna (*pars*) Gregory, Quart. Jour. Geol. Soc. Lond., vol. li, p. 265, 1895.

Platygyra clivosa Vaughan, op. cit., p. 57, 1901.

This species is easily distinguished by its narrow actinal grooves and generally simple, solid ridges; by the crowded septa, alternately larger and smaller, and not rising much above the wall; by the number of septa to a centimeter, which is 28 to 36, usually about 30; by the narrow, interrupted columella; and by the nodose, gibbous, or lobulated character of the coral, except when young.

* Notice of a Remarkable Case of Combination between two different Genera of Living Corals, Bull. Amer. Mus., xiv, p. 221. I have recently examined this specimen, with Mr. Whitfield.

Gregory (op cit., 1895, p. 265) erroneously united this and the preceding species. They are certainly clearly distinct. The name *clivosa* has unquestionable claims to priority.

This coral does not occur at the Bermudas, but it is very abundant and large on the Florida reefs and at the Bahamas, as well as farther south, throughout the West Indies, and at Colon.

This species varies extensively in the length and form of the calicinal grooves. Usually they are long and very sinuous, but in many specimens part of them are, in certain parts, shorter and circumscribed, with some oval or angular astreiform calicles, especially on the flat or depressed portions, between the nodules.

Var. *dispar* V. nov.

I have already alluded (p. 68) to a Florida specimen in the Yale Museum that has a large part of the flat basal mass covered with more or less short and circumscribed angular calicles, much like those of *M. Agassizii*. But on the nodules they are long and sinuous, as usual. Florida Reefs, coll. E. B. Hunt.

Var. *explanata* V. nov. Plate xiv, figure 2.

When young this may form rather thin encrusting plates, often with their spreading, or even free and foliaceous edges somewhat resembling a *Merulina*. In this condition the septa are more loosely arranged and obliquely inclined; the collines become small, narrow, and sharply triangular, close to the edge, and the valleys become shallow and flat, most of them having short, rudimentary collines dividing them into two. Detached fragments of this form might easily be mistaken for a distinct species.

Colon, Yale Museum, coll. F. H. Bradley.

Mæandra varia (Dana) Ver.

> *Astræa (Fissicella) varia* Dana, Zooph. U. States Expl. Exp., p. 236, pl. xii, figs. 13a, 13b, 1846.
> *Prionastræa ? varia* Edw. and Haime, Hist. Nat. Corall., ii, p. 524, 1857
> *Goniastræa varia* Verrill, Bull. Mus. Comp. Zoöl., i, p. 48, 1864.

Of this rare species, supposed to be West Indian, I have seen only few specimens and have none at hand for figuring. Dana's type I have not seen. He does not state where it was placed. However, Dana's description and figures indicate that this is a *Mæandra* with mostly circumscribed, *Goniastræa*-like calicles, much as in the next, but with a more cellular structure.

Meandrina spongiosa Dana is entirely unlike this species, to which Dana thought it might be united as a variety.

The type of the former is in the Museum of Yale University. It is one of the *Cœloria*-group, with larger, open, mostly polygonal calicles, rather few septa, and with a very cellular texture, as seen in sections. Its origin is very uncertain. I do not think it probable that it came from the West Indies, as Dana supposed. No recent collector has found it in American waters, so far as I know. See pl. xiv, fig. 3.

Mæandra Agassizii (Edw and Haime)

Astræa reticularis Dana, Zooph. p 237, pl xii, figs 9–9c (*non* Lam.) = *Prionastræa? Agassizii* Edw. and Haime, Hist. Corall., ii, p 524, 1857

Plate XIV. Figures 1, 1a

This rare species when well grown forms compact, even, hemispherical masses, a foot or more in diameter. Such a mass, from the Bahamas, in the Museum of Yale University, is ten inches across and about six thick. A large part of the calicles are simple, astræiform, angular, often hexagonal or pentagonal, like those of a *Goniastræa*, separated by narrow rather acute walls. But in many places, especially toward the borders, they form more or less elongated, mæandriniform grooves, which often become branched and convoluted, as in typical *Mæandra*. Some of these actual grooves become one to two inches long (25 to 50^{mm}); 2.5 to 4^{mm} wide; they are separated by regular ridges, similar to those of *M. clivosa*, but smaller and more regular. The mændriniform grooves are often mixed with astræiform calicles, and all intermediate forms may occur on one specimen. The ridges are rather high, rounded or with a gothic profile, and have a simple, solid wall; they are about 2 to 3^{mm} wide. The septa are numerous, very thin, close, pretty regular, about 25–30 to a centimeter, and they project but little above the wall. The edge is finely serrulate and there is a small but distinct paliform lobe. The columella is well developed, spongy, composed of small convoluted laminæ, as in most other species of the genus.

On those parts where most of the calicles are simple and regular, they are mostly from 4 to 7^{mm} in diameter; double ones are from 12–14^{mm} long.

This species has not been found at the Bermudas and probably not on the Florida Reefs. Most specimens that I have seen have been from the Bahamas, where it seems to be rare. It is generally mistaken for a *Goniastræa*, which it often closely resembles, but it is closely related to *M. clivosa*.

Mæandra areolata (Linné).

Madrepora areolata (*pars*) Linné, Syst., ed. x, p. 795, 1758. Pallas, Elench. Zooph., p. 295, 1766; ? Ellis and Sol., Nat. Hist. Zoöphytes, p. 161, pl. xlvii, figs. 4, 5, 1786.

Madrepora areola (*pars*) Linné, Sys. Nat. ed. xii, p. 1274, 1767. Esper. Pflanz., i, pp. 76, 84, pl. v, figs. 1–4, young, worn; and *Madrepora meandrites* (*pars*), pl. iv, figs. 1, 2, adult, 1788.

Mæandra areola Oken, Lehr. Naturg., i, p. 70. 1815.

Meandrina areolata Lam., Hist. Anim., ed. i, vol. ii, p. 247, 1816 (*non* Linné, ed. x). ? Lamouroux, Expos. Method., p. 55, pl. xlvii, fig. 5, 1821 (reprint of plate of Ellis and Sol.).

Manicina hispida + *Manicina prærupta* + ? *Manicina manica* Ehrenberg, Corall. Rothen Meeres, p. 336, 337 [102, 103] 1834 (*non M. areolata*, p. 103).

Manicina areolata Dana, Zoöph. U. S. Expl Exp., p. 191, pl. ix, fig. 3, 1846 Edw. and Haime, Corall., ii, p. 397, 1857. Verrill, Bull Mus. Comp. Zoöl., i, p 48, 1864. Pourtalès, Florida Reefs, Corals, Mem. Mus. Comp. Zoöl., vii, pl. v, figs. 1–22, pl. vi, figs 1–7, 1880.

Manicina ? dilatata + *M. prærupta* + *M. hispida* Dana, Zoöph. Expl. Exped., pp. 191–193, pl. ix, fig. 3, 1846.

Manicina strigilis + *M. hispida* + *M. Danai* + *M. Valenciennesi* Edw. and Haime, Hist. Corall., ii, pp 399–401. 1857.

Plate XI. Figures 1, 2. Plate XII. Figures 1, 2, 3.

This very common Florida and West Indian species does not occur at the Bermudas.*

It varies greatly in form and in the height, breadth, and form of the actinal grooves and intervening ridges. These are generally more or less regular infoldings while the coral is young, but in large specimens they become forked and more or less convoluted, finally assuming, in old specimens, the meandriniform arrangement. The actinal grooves are, however, always much wider, deeper, and more open than in either of the three preceding species. The septa are generally strongly granulated or subhispid on the sides and roughly denticulated on the edges, with a broad basal paliform lobe. It is pedicellate when young, but usually becomes free when old.

Some of the nominal species, quoted in the synonymy, were based on beach-worn specimens, which look very unlike fresh ones.

The name *Madrepora areolata* was first applied by Linné (Syst., ed. x, p. 795, 1758) chiefly to the East Indian coral now generally known as *Trachyphyllia amarantum* Edw. and Haime. Ehrenberg's *Manicina areolata* was probably the same or a related species (*T.*

* The fossils mentioned by Nelson as belonging to this species were probably *Mycetophyllia* (see p. 68, note).

Geoffroyi E. and H.). The former should be called *Trachyphyllia amaranthus** (Müll.).

Linné evidently had the East Indian species in view when he established the species *M. areolata*, for he quoted a recognizable figure of it (Rumphius, Amb., 6, p. 244, pl. 87, fig. 1), and gave "O. Asiatico" as its habitat. His diagnosis is so indefinite that it would apply to either species. This name should properly have been restricted to the East Indian coral, but in view of the whole history of the name, and especially in consequence of the early application of the name, *amaranthus*, by Müller, 1775, to the oriental species, the name *areolata* should continue to be used for the American coral.

Linné, however, quoted Petiver, Pterigraphia Americana, pl. xx, fig. 16, 1712, which undoubtedly refers to the American species. In the ed. xii, p. 1274, he arbitrarily changed the name to *areola*, keeping the same diagnosis, with slight changes.

Pallas (1766, p. 275) added the American species to that of Linné, and quoted references to both in earlier books, though his diagnosis applies best to the East Indian species.

Esper's name (*areola*) was applied mainly to the West Indian species, which he figured. His additional figure on pl. iv, figs. 1, 2, erroneously referred by him to *meandrites*, represents an old specimen with more or less convoluted grooves, such as are of frequent occurrence in favorable situations. It is represented with wide grooves; serrulate septa; and narrow subacute ridges, double in some places.

Dana's *M. dilatata* was based on a figure in Ellis and Solander, pl. xlvii, fig. 4. He apparently had no specimen. The figure is not determinable with certainty. It looks like a young *Trachyphyllia amaranthus*. But it might have been made from a poor drawing of a beach-worn, young *M. areolata*. Hence I place *M. dilatata* here as a doubtful synonym. In either case the name is useless

The most important variations in this species are those that are due to the number and closeness of the septa; the amount of

* According to Bruggmann (Abhand. naturwiss. Vereins, Bremen, 1878, 549) the name *Madrepora amaranthus* was given to this coral by Ph. L. S. Müller in 1775 (German ed. Linné, Syst. Nat., vi, ii, p. 682, which I have not seen), and he proposed to call it *Trachyphyllia amarantus*. But it seems more desirable to follow Müller's spelling and call it *T. amaranthus* (Müll.). "Sea amaranth" was its ancient vernacular name. The specific name *amarantum*, as it was given by Dana, was based on a mistake in spelling. Rumphius called it *Amaranthus saxeus*.

columella; and the solidity or vesicular character of the collines. Some of these forms are, perhaps, worthy of varietal names:

Var. *hispida* (Ehr.)=*M. prærupta* Dana (*non* Ehr.).

The type of Dana's *M. prærupta* is in the Yale Museum. It is a variety of *M. areolata*, with the collines mostly solid, narrower than usual, and partly sinuous. Septa rather narrow, thickened at base, emarginate, hispid laterally, roughly serrulate; columella largely developed, finely lamellose. The collines are thin and simple in some places, but double in others. The valleys are mostly broad and open, 12 to 20mm wide, usually about 15mm; collines mostly 4 to 6mm wide. Pl. xii, fig. 2, type of Dana.

Florida Reefs.

Var. *confertifolia* V., nov.

PLATE XI FIGURE 2.

Form as usual. Collines generally wide, double, truncate or sulcate, sometimes simple, rather compact. Septa numerous and crowded, alternately wider and narrower, about 11 to 12 wider ones to a centimeter, not very hispid laterally, finely and pretty regularly serrulate, usually wide and rounded distally, and with a broad basal paliform lobe. External costæ numerous, pretty evenly spinulose. Columella usually well developed, spongy or finely lamellose. Calicinal valleys wide and open, mostly about 20mm wide, sometimes 25mm; collines mostly 10 to 12mm broad.

Florida Reefs. Yale Museum.

Var. *laxifolia* V, nov.

PLATE XII. FIGURE 1.

Form as usual, but generally with lobulate margins. Valleys usually narrower than in the preceding variety, rather deep, often with perpendicular walls. Collines short at first, but branched and sinuous when older, mostly narrow, generally double, often becoming simple when older, usually with very cellular exotheca. Septa fewer than usual, and less crowded, about eight or nine wider ones to a centimeter, with small ones alternating, so openly placed that the interseptal spaces appear unusually wide and conspicuous, rather wide and rounded distally, moderately hispid laterally, pretty evenly and sharply serrulate, but the large, rounded paliform lobe is often lacerate-toothed. Columella well developed, finely lamellose. Exterior costæ prominent, sublamellar, sharply serrulate. Valleys mostly 10 to 13mm wide; collines 5 to 12mm wide.

Florida Reefs and St. Thomas. Yale Museum.

Var. *columellaris* V., nov.

Form as usual. Septa numerous, crowded, much thickened toward the base and very strongly hispid laterally, edges roughly serrulate and lacerate. Columella highly developed, broad, trabecular or finely lamellose, the lamellæ often largely coalescent and rough on the surface. Valleys usually wide and open. Collines either single or double, often sulcate. This is near var. *hispida* (Ehr.), in the hispid character of the septa.

Florida Reefs. Yale Museum.

Var. *angusta* of Dana, p. 196, I have not seen. It may have been based on a young example of *M. labyrinthiformis.*

Mæandra conferta Ver

Favia conferta Verrill, these Trans., vol. i, p. 355, 1868
Favia conferta (pars) Vaughan, op. cit , pp 39, 40, 1901

PLATE XIII. FIGURE 6

Although this species has the aspect of a *Favia*, near *F. fragum*, when the calicles are mostly simple and elliptical, other specimens, and often even different parts of the same specimen, have more or less elongated, narrow cells or valleys, with several indistinct actinal centers, nearly as in *M Agassizii* and parts of *M. clivosa.* These short valleys are often curved, or bent a little in sigmoid shape, but are not sinuous. They are then separated by small, narrow, solid collines.

It is evidently closely related to *M. varia*, but has much narrower calicles and valleys, and still more of the valleys are circumscribed. The septa are thinner and more numerous, rather regularly serrulate.

Brazil, at Pernambuco, Bahia, the Abrolhos Reefs, etc. Yale Mus., coll. Hartt; Rathbun.

Vaughan (op. cit., 1901) thinks that this species is not distinct from *Favia gravida* Ver. It seems that they must be referred to distinct genera. (See p. 91.) I have figured one of the types.

Subfamily **Trachyphylliinæ** Ver , nov.

Mæandriform corals that have distinct calicinal centers and radiating septa. (See p. 65.)

Manicina versus **Colpophyllia.** Type *M. gyrosa* Ehr.

Podasteria (provisional name) Ehr., p. 101, 1834.

If we consider *M. areolata* (L.) as congeneric with *Mæandra*, as above explained (p. 67), the name *Manicina* must either be dropped altogether for a genus, or else applied to some other type. By the

process of elimination, the last subdivision of *Manicina* Ehr. to receive a name was the group named *Gyrosmilia* in 1851. This was based on *M. interrupta*, the second species under *Manicina* in Ehrenberg's list,* pp. 101–103.

But *Gyrosmilia* is generally regarded as inseparable from *Plerogyra* E. and H., 1848 (*Euphyllia*, *pars*, Dana, 1846). It is doubtful whether *Plerogyra* can be kept as a genus distinct from *Euphyllia*, from which it differs chiefly in the loose union of the walls.

On p. 102, under *M. gyrosa*, Ehrenberg states that *gyrosa* does not agree with the generic characters, and proposes for it a provisional generic name (*Podasteria*). This might take the place of *Colpophyllia*† according to strict rules of priority, but he gives no definition of the generic characters, nor does he refer to it his *fissa* (sp. 6) and *mæandrites* (sp. 7), though they are probably all forms of the same species (*gyrosa*).

It seems best, therefore, to restrict the name *Manicina*, if it is to be retained for a genus, to the group named *Colpophyllia* E. and H , with *M. gyrosa* as the type. *Podasteria* and *Colpophyllia* would thus become strict synonyms of it. It is doubtful whether more than one species is known, most, if not all, of the several named species being mere forms of *gyrosa*.

This would surely produce the least disturbance in the current nomenclature. The only alternative would be to restore it to the second and third species = *Plerogyra* + *Gyrosmilia* E. and H. But in case these should be united to *Euphyllia* D. (1846), as is likely, the name would again lapse or else come back to *Colpophyllia*

Another view may, possibly, be reasonably held. *Manicina* (E. and H.) by some may be thought worthy of recognition as a section or subgenus of *Mæandra*, with *M.* (*Manicina*) *areolata* as the type. But I know of no structural characters by which such a group can be distinguished.

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* The 1st species is a *Mussa* (E. and H); the 2d is type of *Gyrosmilia*, 1851 = *Plerogyra* E. and H., 1848; 3d is *Plerogyra*; 4, 6, 7 are *Colpophyllia* E. and H , 1848 = *Podasteria* Ehr , 1834; 5th is *Mæandrina* (revis.) = *Pectinia* Oken; 8, 9, 10 are *Mæandra*, restr., Oken; 12 is *Tridacophyllia* Blainv., 1830. The 11th, *M. areolata* Ehr. (*non* L.), is doubtful. Edw. and H. refer it to *Trachyphyllia Geoffroyi*, but the description in Ehr. does not apply to a *Trachyphyllia*, for it implies true sulcated collines, "*truncatis, passim fissis.*" It is indeterminable from the description.

† Ehrenberg's three species, Nos. 4, 6, 7, all belong to *Manicina* (*Podasteria*) *gyrosa* (or *Colpophyllia gyrosa* E. and H.), according to Vaughan, who has recently examined the types of Ehrenberg, in Berlin.

The principal distinctions between *areolata* and *Colpophyllia* is the presence of well defined calicinal centers and radial septa in the latter, while in the former they are indistinct, as in *Mæandra;* and the absence of a columella in *Colpophyllia.*

Callogyra V., gen. nov.

Coral pedicelled; calicles large and with very distinct centers in deep valleys, mostly united in short series. Collines large, with simple or double walls united by exotheca. Septa with paliform lobes; edges finely serrulate. Columella trabecular. Outer surface naked, covered with spinulose costæ. Endotheca not abundant, deep within the interseptal spaces.

This genus is like a *Trachyphyllia* with coalesced walls, and might, indeed, be considered a section of that genus if intermediate conditions were known. It bears about the same relations to that genus that *Symphyllia* does to *Mussa*, or *Plerogyra* to *Euphyllia.*

In form, the type resembles the *Manicina areolata* of authors, but differs widely from it in its large, distinct calicles, and finely and evenly serrulate septa. It also has a general resemblance to *Meandrina* (*Pectinia*) *Braziliensis*, but the latter has entire septa and the calicinal centers are not distinct.

It is also nearly allied to *Manicina*, emended = *Colpophyllia* E. and H., but the latter forms more massive and cellular corals, without a columella, and has different exterior costæ, and less distinct calicles.

Callogyra formosa V., sp. nov.

PLATE XXIV. FIGURES 1, 2.

The coral is narrowly pedicelled, glomerate, elliptical, with lobed margins and with high radial collines, more or less forked and curved, much as in *Isophylliæ* and young *Mæandræ.* Between the collines are large marginal calicles, which render the margin lobulate; two large calicles occupy the central valley. The valleys are deep and rather wide, the central ones with perpendicular walls. The calicinal centers are very distinct and occupied by a loose trabecular columella. The collines are simple in some places, with a thin wall, but in most places they are double with two thin walls near together; their summits are obtusely rounded.

The septa are thin with wide interspaces; their breadth is moderate; lengths very different, corresponding to the five cycles to which

they generally belong, the smallest being quite short. The larger ones have wide but slightly marked paliform lobes and are broadly rounded at the summits; their surfaces are finely granulate, and costulate close to the border; their edges are very finely and regularly denticulated.

The under side is covered with elevated, lamellate, radial costæ, which are sharply and closely dentate on their edges, the teeth being small and spiniform.

Length of the coral, 75^{mm}; breadth, 60^{mm}; width of the valleys mostly 13 to 25^{mm}; depth, $10–18^{mm}$.

The type is from an unknown locality, but was supposed to be West Indian. It belongs to the American Museum, New York.

From its affinities with *Trachyphyllia*, I think its origin is more likely Indo-Pacific.

There is a smaller worn specimen in the Museum of Yale University, locality unknown.

Subfamily **Favitinæ** Ver., nom. nov.

This subfamily is intended to include all the astreiform corals that normally or chiefly increase by fission or by intracalicinal budding, for these two methods intergrade completely and often coexist on the same coral. It is thus nearly equivalent to *Fissicella* of Dana. Paliform lobes or teeth are generally present.

This group is very closely related to *Mæandrinæ*. The principal difference consists in the more complete fission of the zoöids and the rapid and usually complete isolation of the calicles, which may be either circular or angular.

Perhaps it would have been thought better by many to have considered the group a distinct family near *Mæandridæ*, under the name *Favitidæ*. But the study of such species as *Favia gravida* and *F. fragum*, in comparison with *Mæandra conferta*, *M. Agassizii*, and *M. clivosa*, var. *dispar*, shows that the two groups nearly intergrade.

The occasionally isolated calicles of *Mæandra* are structurally identical with those of *Favia*. Perhaps the two groups are not even of subfamily rank.

I have used *Favites* as the typical genus from which to form the family name, because the ultimate fate of *Astrea* and *Favia* is still uncertain. (See p. 89.)

Favia Oken, 1815, restricted by Edw and Haime, 1857 Star Corals

Astrea (1st section) Lamarck, Syst Anim s Vert, p 371, 1801, (*pars*) Hist. Anim, ii, p 60, 1816

Favites (*pars*) Link, Beschr Nat-Samml, Univ Rostock, iii, p 162, 1807

Favia (*pars*) Oken, Lehrb Naturg, i, p 67, 1815

Astrea, subgenus *Fissicella* (*pars*) Dana, Zoöph, p 220, 1846

Parastrea Edw and Haime, Compt-rendus, xxvii p 495, 1848. Ann Sci Nat, xii, 1850

Favia Edw and Haime, Hist Nat Corall, ii, p 426, 1857, Verrill, these Trans, i, pp 353–355, 1868

Astrea Verrill, Comm Essex Inst, v, p 33 1865, Verrill, in Dana Coral Islands, pp 380, 388, 1874

Astræa Quelch, Reef Corals, Chall Exped, xvi, 1886

The name of this large genus has been much in question for a long time. This is due to several reasons When *Astrea* was first proposed by Lamarck (1801) he gave it two sections with a single species as an example of each. His first section had *A. rotulosa* as its type. The second section had *A. galaxea* (=*radians*) as the type. Properly the name should have been retained for the former, as the more typical and first named

But Oken, 1815, made two divisions similar to, but not the same as those of Lamarck, and applied the name *Favia* to the group more like the first of Lamarck's sections, and *Astrea* to the second. Blainville, in 1830, named the latter *Siderastræa*.

But under *Favia* Oken named three species, which belong to three modern genera, viz: 1. *F. ananas*=*F. fragum*; 2. *F. cavernosa*=*Orbicella cavernosa*; 3. *F. favites* or *favosa*=? *Prionastræa abdita* E and H =*Favites* Link.

The true relations of *A. rotulosa* Ellis and Sol, Lamarck's first type of *Astrea*, are still doubtful. It was referred to *Favia* by Edw. and Haime, perhaps erroneously. Their species, thus named, may very likely be different. It has much larger calicles, more numerous septa, and they place it in the section with feeble pali. The general appearance of the original figure is more like an *Orbicella* or *Plesiastræa*. It has a circle of very distinct, prominent pali, in which it agrees with *Plesiastræa*. The calicles are regular and circular and the septa are few and very prominent. I have never seen a perfect specimen of it A few beach-worn West Indian corals that I have seen may belong to it, but they are not positively determinable.

It may be an East Indian coral of the *Plesiastræa*-group. In that case *Astrea*, if retained, should be restricted to this, as the original type, and thus it would be distinct from *Favia*.

The name *Favites* was given by Link, 1807, to a genus nearly equivalent to *Astrea* Lam. and *Favia* Oken, of which it could be considered a synonym. It included four genera. Vaughan (op. cit., 1901, p 21) proposed to restore the name for a part (the *favosa*-group) of Link's genus, and thus use it in place of *Prionastræa*. It might have been substituted, equally as well, for *Favia* (in the usual sense) for the latter was practically synonymous. But Vaughan is justifiable in considering *favosa*=*abdita* as the proper type.*

There is an additional reason why *Astrea* is rejected by some writers, as by Vaughan (op. cit., 1901, pp. 60, 61).

Bolten used the name *Astræa* for a group of gastropod shells in 1798. His genus was not properly defined and has never come into use. It included species usually referred to *Turbo* (L.) and *Xenophora*. Whether it should be restored for any of these shells is very doubtful. Bolten's work was a mere catalogue, not a scientific work in any legitimate sense, and it is extremely rare. Still his names are recognized by many malacologists.

The difference in the original spelling of the two names would, perhaps, be a sufficient reason for retaining both, if not otherwise invalid.

It seems to me necessary to wait for the re-examination of the true *Astrea rotulosa* before the status of *Astrea* can be settled.

However, it would evidently lead to less confusion to reject *Astrea* altogether, on the ground of its prior use by Bolten, than to use it for *Siderastræa*, as some have done, for the latter does not belong to the group *Astræidæ*, but is a fungian coral.

Astrea is said to have been used by Gmelin, 1789 (see L. Agassiz, Nomencl. Zoöl., and Gregory, op. cit., p. 278). The latter cites it as on p. 3767, under *M. astroites*. But the name is used there only as a part of a polynomial name quoted from Browne (Hist. Jamaica, 1756, p. 392), with other descriptive quotations, and in no sense as a generic term. Browne gave several species of *Astrea*, but he used the term only as a part of his *polynomial* descriptive names.

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* *Favites* Link (*pars*)=*Fissicella* (*pars*) Dana=*Prionastræa* Edw. and H. + *Metastræa* E. and H. For a review of the principal species see p. 92.

Favia fragum (Esper) Edw. and Haime.

Madrepora ananas (*pars*) Pallas, Elench. Zooph., p. 321, 1766 (not of Linné, Syst. Nat., ed. x, 1758, p. 797, which was a palæozoic fossil (*Acervularia*), from Gothland.

Madrepora ananas (*pars*) Linné, Syst. Nat., ed. xii, i, p 1275, (not of ed. x,) 1767.

Madrepora ananas Ellis and Solander, Nat. Hist Zooph., p. 168, pl. xlvii, fig. 6, 1786.

Madrepora fragum Esper, Pflanzenth., Fortsetz., i, p. 79, pl. lxiv, figs. 1, 2, 1797 (*non Madrepora ananas* Esper, Pflanzenth., pp. 128–131, pl. xix, which is a *Dichocœnia*.)

Favia ananas (*pars*) Oken, Lehrbuch Naturgesch., Zool , i, p 67, 1815.

Astrea ananas Lamarck, Hist. Nat. Anim. s. Vert., ii, p. 260, 1816.

Astrea ananas LeSueur, Mem Mus. Hist. Nat. Paris, vi, p 285, pl. xvi, fig 12, 1820.

Astrea ananas Lamouroux, Exp. Meth Gen. Polyp., p. 59, pl. xlvii, fig. 6, (after Ellis and Sol.)

Favia ananas and *Favia fragum* Milne-Edwards and Haime, Hist. Nat. Corall., ii, pp. 485–489, 1857.

Favia incerta, p. 351 [75], pl. x, figs. 13, 14; +*Favia coarctata*, p. 352 [76], pl. x, figs. 17, 18; +*Favia ananas*, p. 352, Duchassaing and Michelotti, Mem. Corall. Ant., 1861 (t. Vaughan, from types).

Favia ananas Verrill, Bull. Mus. Comp. Zoöl., i, p. 48, 1864.

Favia fragum Verrill, these Trans., i, p. 355, 1868.

Astræa ananas and *A. coarctata* Quelch, Narrative Chall. Exp Zool , i, pt. i, foot-note, p. 146, 1885.

Astræa coarctata, pp. 9, 12, 98; +*Astræa incerta*; +*Astræa ananas*, p. 12, 98; +*Astræa fragum*, pp. 13, 98, 99, Quelch, Reef Corals, Chall. Exp. Zoöl., xvi, 1886.

Favia ananas Gregory, Quart. Jour. Geol. Soc. London, li, p. 260, 1895.

Favia fragum Vaughan, Samml. Geol. Reichs-Mus., Leiden, ii, p. 24, 1901.

PLATE XIII. FIGURES 1, 2.

The name *ananas*, as applied to this species, dates from Pallas, 1766, who described it very well indeed. But the name, as used previously by Linné (Syst., ed. x, p. 797) was particularly applied to a Gothland fossil coral of the genus *Acervularia*. So it should, without doubt, be dropped for this living species, to which it has been so long applied. However, this name has also been applied, by the earlier writers, to other existing species, so that its synonymy is complex. Fortunately the early name *fragum* is available and has, apparently, not often been applied to other species, so that its use for this one can hardly lead to any confusion. My own experience, based on a study of large numbers of specimens, living and dead, is in accord with that of Mr. Vaughan, as to the necessity of uniting the several forms described by Duch. and Mich. and by Quelch as

distinct species. The differences noticed are due to slight variations in growth, and especially to the greater or lesser crowding of the calicles. Sometimes the intervening spaces are very narrow; in other specimens, and more commonly, they are rather wide. The calicles may be circular, angular, or elliptical. The extreme forms occur associated together in tide-pools at the Bermudas, but intermediate specimens also occur in the same places. In life, the soft parts agree in color and structure.

My figures (pl. xiii, figs. 1, 2) are from photographs of two Bermuda specimens, found together. They show nearly the extreme forms of variation. The color of the soft parts, in life, is light yellow.

This coral is common on the Florida Reefs, and throughout the West Indies in shallow water. It is also abundant at the Azores. (t. Quelch.) It never becomes large.

Favia gravida Ver.

Favia gravida Verrill, these Trans., i, p. 354, 1868

Favia conferta (*pars*) Vaughan, op. cit., pp 39, 40, 1901 (*non* Verrill)

PLATE XIII. FIGURE 3.

This Brazilian species is nearly allied to *F. fragum* of the West Indies. I do not think it is so closely related to *M. conferta* as Vaughan supposes, for he has united the two forms under the latter. (See p. 84.) I have never found mæandriniform calicles or valleys as in the latter, and the septa, columella, and sections of the walls are different.

I have here figured one of the types.

Abrolhos Reefs, Bahia and Pernambuco, coll. C. F. Hartt; R. Rathbun.

Favia leptophylla Ver

Favia leptophylla Verrill, these Trans., i, p. 358, 1868

PLATE XIII. FIGURES 4, 5.

This species is very unlike any of those forms related to *F. fragum*. It has double walls and vesicular exotheca between the calicles. The proper walls are thin, continuous; those of adjacent calicles are separated by a loose, vesicular structure, with thin dissepiments. The septa are rather few, very thin with rather prominent summits. This species produces some intermural buds, but it increases mainly by fission.

The photographs here reproduced are from the original type, now in the Museum of Yale University.

Abrolhos Reefs, Brazil, coll. C. F. Hartt.

Favites Link, 1807, restricted.

Favites Link (*pars*), op cit, p 162, 1807
Favia (*pars*) Oken, Lehrb Naturg, i, p 67, 1815
Fissicella (*pars*) Dana, Zoöph, p 220, 1846.
Prionastræa Edw and Haime, Comptes-rend, xxvii, p 495, 1848
Prionastræa and *Metastræa* Edw and Haime, Hist Corall, vii, pp 513 and 525, 1857

Calicles usually angular or polygonal, separated by nearly solid walls, which often contain a single series of cellules, more distinct toward the base. The division of the calicles is generally excentric, or near the margin, by unequal fission or intracalicinal budding, but it may also be by median fission, where the calicles become crowded, or in the central parts Septa rather numerous, denticulated, the larger teeth usually proximal. Columella developed more or less, spongy or trabecular Pali usually distinctly developed

The history of the name of this genus has been discussed on page 89.

This large genus appears to be absent from the West Indian fauna. The American species, hitherto referred to it, belong in other groups, so far as I have seen them. Among the better known Indo-Pacific species are the following, most of which I have studied personally :—

Favites favites (Pallas, *not M. favosa* L., ed. x, which was a fossil) = *P. abdita* (Lam.) E. and H. East Indies; Singapore

F. profundicella (E. and H.).

F. crassior (E and H).

F. magnifica (Bv.; E. and H.) (*non* Dana). Batavia.

F. magnistellata (E. and H.).

F. obtusata (Lam.; E. and H). Tongatabou; Fiji.

F. sulfurea (E. and H.). Vanikoro.

F. Quoyi (E. and H.). New Ireland; Fiji

F. Ellisiana V. (nom. nov.) = *M. favosa* Ellis and Sol., Hist., p. 167, pl. 1, fig. 1, 1786, *non* Linné = *Prionastræa favosa* E. and H, *non* Linné.

F. fusco-viridis (Q. and G.; Dana) Tongatabou; Fiji.

F. virens (Dana). Fiji.

F. flexuosa (Dana). Fiji.

F. spectabilis (Ver.) = *Astræa magnifica* Dana, *non* Blainv. = *P. spectabilis* Ver. East Indies.

F. sinuosa (Dana). Fiji.

F. favulus (Dana). Fiji.

F. coronata (Studer, 1881) Singapore.

F. robusta (Dana). Fiji; Amboina.

F. valida (Ver.)=*Astræa heliopora* (*pars*) Dana, p. 246, pl. xiii, figs. 11*a*, 11*b*. Wakes I.

F. tessellata Ver., nom. nov.=*A. tesserifera* Dana (*non* Ehr.).

F. Chinensis (Ver.)=*Prionastræa Chinensis* Ver., Comm. Essex Inst., v, p. 35, 1866. Hong Kong.

F. armata (Ver.)=*Astræa intersepta* Dana, Zoöph., p. 246, pl. xiii, figs. 12*a* to 12*d* (*non* Esper,=*Stephanocœnia*)=*Plesiastræa armata* Ver. in Dana, Coral Is., ed. ii, p. 381.

F. coronella Ver., sp. nov. = *Astræa parvistella* (*pars*) Dana, Zoöph., p. 244, but not the figures. One of Dana's specimens differs from the type. Calicles small, (2·5 to 3·5^{mm},) angular, separated by narrow, nearly solid walls. Septa unequal, in three cycles or more, usually 24 to 30, those of the 3d cycle very narrow, the larger ones roughly serrate and strongly granulated ; six prominent pali before the primary septa ; columella nearly solid. Endothecal dissepiments regular, nearly horizontal, not crowded. This and the next preceding might be referred to *Goniastræa* about as well as to *Favites*. Fiji.

The following are from the Red Sea :

F. gibbosa (Klunz., p. 40, pl. iv, fig. 10, as *Prionastræa*.

T. pentagona (Esp.; Klz., *non* Ehr.,=*P. melicerum* E. and H.

F. spinosa (Klunz., p. 39, pl. iv, f. 7, pl. x, f. 5).

F. vasta (Klunz., p. 38, pl. iv, f. 8, 12, pl. x, f. 4*a*, 4*b*, as *Prionastræa*).

F. tesserifera (Ehr.; Klz.; E. and H.).

F. Ægyptorum (Edw. and H.)=*Metastræa Ægyptorum* E. and H. Recent and fossil.

Family **Orbicellidæ** Ver. Star Corals.

This family will include the astreiform corals that have circular or nearly circular calicles, and increase by mural or exothecal budding. The polyps, when expanded, are exsert.

Orbicella (Dana), restricted.

Astræa, subgenus *Orbicella* (*pars*), Dana, Zoöph. Expl. Exped., p. 206, 1846.
Heliastræa Edw. and Haime, Hist. Corall., ii, p. 456, 1857.
Orbicella Verrill, Bull. Mus. Comp. Zoöl., i, p. 47, 1864. Verrill, in Dana's Corals and Coral Islands, ed. 1, p. 380, 1872; ed 2, pp. 380, 388, 1874 ; ed. 3, pp. 421, 429, 1890.

Corallites cylindrical or nearly so. Costæ well developed and serving, with more or less cellular intercostal exotheca, to unite the corallites. Septa exsert ; paliform teeth and columella are present.

Orbicella annularis (Ellis and Sol.) Dana. **Star Corals.**

Madrepora astroites Pallas, Elench. Zoöph., p. 320, 1766 (not of Linné, ed x, p. 796, which was a palæozoic fossil, nor of ed. xii)

?? Madrepora acropora Linné, Syst. Nat., ed. xii, p 1276, 1768. (Probably not this species, perhaps a *Solenastræa*, but indeterminable.)

Madrepora annularis Ellis and Solander, Nat. Hist Zooph , p 169, pl. liii, fig 1, 2, and *Madrepora faveolata*, p. 166, pl. liii, figs 5, 6, 1786.

?? Madrepora acropora Esper, Pflanzenth., Fortsetz , i, p 21, pl xxxviii, 1797, (*non* Linné, Syst , ed., xii, p, 1276.)

Astrea annularis Lamarck, Hist. Nat. Anim s Vert , ii, p. 259, 1816

Astrea annularis Lamouroux, Exp. Meth. Genres de Polyp , p 58, pl liii, figs. 1, 2, and *Astrea faveolata*, p. 58, pl liii, figs 5, 6, 1821.

Astrea (*Orbicella*) *annularis* Dana, Zoophytes U S. Expl. Exp., p 214, pl. x, fig. 6, and *? A (O) stellulata*, p 215, pl. x, fig 7, (variety,) 1846

Heliastræa annularis Milne-Edwards and Haime, Hist Nat. Corall , ii p 473; and *? Heliastræa acropora*, p. 477, 1857.

Heliastrea annularis ; + H. acropora ; + H Lamarcki Duchassaing and Michelotti, Mem. Corall. Antilles, p. 352, [76], 1861 (t. Vaughan from types, *non H Lamarckana* E. and H.).

Orbicella annularis Verrill, Proc Boston Soc Nat. Hist., ix, p. 33, 1862, rate of growth.

Phyllocœnia sculpta + P. limbata + Cyphastræa costata (*pars*) + *Astræa Barbadensis* Duncan, Quart. Journ. Geol. Soc. London, xix, pp 432-444, pl xv, figs. 6, 6*a*, 1863, all fossils, (t. Vaughan from types)

Plesiastræa ramea Duncan (fossil), op. cit., xx, p 39, 1864 (t. Vaughan)

Orbicella annularis Verrill, Bull. Mus. Comp Zoöl , i, p 48, 1864; Pourtalès, Flor Reefs, Cor., Mem. Mus. Comp. Zoöl , vii, No. 1, pl. iv, figs. 1–10, 1880.

Orbicella annularis A. Agassiz, Bull. Mus. Comp. Zoöl., xx, No. 2, p 61, pls. i, ii, 1890, rate of growth. Verrill, these Trans., x, p. 558, 1900.

Orbicella acropora (*pars*) Gregory, Quart. Jour. Geol. Soc. Lond., li, p. 272 (*non* Linné,); + *Cyphastræa costata*, p. 274; + *Echinopora Franski*, p 274, pl. xi, figs. 2*a*, 2*b*, 1895, (teste Vaughan from types).

Orbicella acropora Vaughan, Bull. Mus. Comp. Zoöl , xxviii, No. 5, p. 275, 1899; Samml. Geol. Reichs-Mus., ii, p. 22, 1901, (not of Gardiner, 1899)

PLATE XV. FIGURE 1.

This common and well known species was admirably figured by Professor L. Agassiz in the plates of Florida Reefs, published by Pourtalès, 1880.

It shows considerable variations in the size of the calicles; in the extent to which they are crowded together; in the prominence of their borders above the intervening exotheca; in the prominence of the septa above the walls; and in the extent to which the small septa of the third cycle are developed. But yet these variations, so far as I have seen, never go so far as to render difficult the recognition of the species, unless the specimens are badly worn.

The specimens from which the figures of *annularis*, *faveolata*, *stellulata*, and *pleiades* were made, in the work of Ellis and Solander, were all badly worn. Hence there has always been much uncertainty as to their identification. However, there seems to be no doubt but that their *annularis* was really this species, and their *faveolata* was probably the same species, more eroded. There is more doubt about *stellulata*. It may be the same thing, but it might be a *Solenastræa*. (See p. 97.)

It seems best, however, to let Dana's determination of the latter stand, for it is as likely to be correct as any other, and is based on types still preserved.

The *M. acropora* of Linné is utterly indeterminable. The locality is unknown, and the diagnosis is so brief and vague that it applies equally well to any one of a dozen or more species of small astrean corals, both Pacific and Atlantic. Nor does the author refer to any figure in earlier works. It is useless and unfortunate to try to apply the name to the present species and to displace a valid and long established name by one of extreme uncertainty, as has been done recently by both Gregory and Vaughan. I do not know any good reason for such a course, in this case. The name *acropora* L.) should be discarded as indeterminable, both generically and specifically. If used at all it should only date from *H. acropora* E. and H.

There is no certainty nor probability that the Linnæan species was the same as *annularis*, nor is there any good reason to believe that the *acropora* of Esper, or of Edw. and Haime was the same as the *acropora* of Linné. Even if the *acropora* of Edw. and Haime should prove to be only a variation of *annularis* (which may still be doubted), it does not follow that the name should be adopted as from Linné (ed. xii), for Edw. and Haime applied this name arbitrarily to the particular form that they had in view. They could have had no more knowledge of this Linnæan species than Esper, Lamarck, Dana, and others, for there is nothing definite on which to base any such knowledge. It is certain that the contemporaries of Linné, like Pallas and Ellis, did not thus identify this species, for they described the *annularis* under other names. The *acropora* of Esper may or may not be the same as *annularis*, but in either case the latter has several years priority. Had this species been what Linné had before him, he would undoubtedly have referred to Pallas, who had already well described it as *M. astroites*, for he referred to the other species described by Pallas. That Pallas had the *annularis* particularly in view, instead of *cavernosa*, in his description of *astroites*, is evident

from what he there says of the size of the calicles, and also when, on p. 326, he compares the stars of *M. porites* with those of his *astroites*, and says they are subequal.

This species occasionally shows certain calicles larger than usual, and with more septa. Such calicles may subdivide by regular fission, as is the case with the similar unusually large cells in some species of *Porites*, *Madrepora*, *Pocillopora*, etc., in which fission is elsewhere very unusual. One of our Bermuda specimens shows such a cell in the very process of subdivision, (pl. xv, fig. 1, A).

This coral occurs on the outer reefs of the Bermudas, but it is not common there. It is very common and grows to a large size on the Florida Reefs, in the Bahamas,* and throughout the West Indies.

When well grown it forms hemispherical or spheroidal masses, up to five feet or more in diameter. But it also grows in irregular incrusting plates, and sometimes in nodose or lobulate masses, or even in branched forms.

Mr. A. Agassiz in the work quoted, 1890, has given some interesting data as to its rate of growth. Other data were given by me in Proc. Boston Soc., x, p. 362, and in Dana's Coral Islands, p. 125.

Variety, **stellulata** (Dana, ex. Ellis and Sol.).

Heliastræa stellulata Edw and Haime, Hist Corall, ii, p 473, 1857.
? *Cyphastræa oblita* Duch and Mich., Corall Ant, p. 77, 1860

PLATE XV. FIGURE 2.

The two types of Dana's *stellulata* are in the Museum of Yale University. They are beach-worn specimens of a true *Orbicella*, more or less infiltrated with calcium carbonate, to which the unusual solidity of the walls and exotheca, in some parts, as seen in sections figured by Dana, seems to be partly due. In other parts the structure is nearly as in *O. annularis*, to which it probably belongs, though there are differences in the sections not due to infiltration. Its septal arrangement is the same as in ordinary specimens of the latter, those of the third cycle being distinct, but narrow and thin. The borders of the calicles seem to have been but little raised, and the septa rather thinner than usual, and not much exsert, but the poor condition of the specimens renders these characters rather uncertain.

The calicles are rather smaller (2 to 2·5^{mm} in diameter) than is usual in *O. annularis*. The thin septa are in three regular cycles; those of the third cycle are very thin and reach only one-fourth or one-

* There is a fine Bahama specimen, about four feet in diameter and three in height, in the Amer Mus., New York (coll. R. P. Whitfield).

third to the columella, which is well developed. The septa are a little thickened at the wall; their faces are only slightly granulated. There are a few irregular small teeth on their inner edges where best preserved; upper ends are all worn off; some have a paliform tooth at the base. The costæ are well developed, inosculating, with irregular exothecal dissepiments between them, as in *O. annularis*. But in some vertical sections the walls appear as narrow, solid structures, (where unaltered); in the sections the columella region is loosely filled with stout ascending trabeculæ; the endotheca consists of small, very thin, nearly horizontal dissepiments, inclining downward a little, and often in two series. No. 4266.

Their origin is uncertain, but it appears to be West Indian. They are in the same beach-worn state as several other types of West Indian corals studied by Professor Dana. Apparently most West Indian corals, in good condition, were scarce in American museums at the time when he wrote his great work.

It appears to be a small or somewhat dwarfed variety of *O. annularis*. I have seen fresh specimens of a similar variety from the Florida Reefs.

This may well be identical with *M. stellulata* Ellis and Sol., but the latter cannot be determined with any certainty from the figure, which represents a badly worn specimen. Its calicles, as figured, are mostly even smaller than in Dana's type, and somewhat unequal in size; the walls appear to be as solid as in the latter; the calicles project slightly as in *annularis*; 12 to 15 septa are figured, all perfect; columella is as in *annularis*. There is much more reason for calling this a variety of *O. annularis* than there is for identifying it with *Solenastræa hyades*, as Gregory has done. There is no evidence that it is a *Solenastræa*.*

* Gregory (op. cit., p. 278, 1895) adopts the name *Solenastræa stellulata* (ex Ellis and Sol.) for *S. hyades* (Dana), and refers *O. stellulata* Dana and *Heliastræa stellulata* Edw. and Haime to it as synonymous. It is probable that Edw. and Haime knew their own genera and that their *stellulata* was not a *Solenastræa*. To me it seems perfectly identical with Dana's form, and only a variety of *annularis*.

It seems strange that Gregory should have tried to restore such indeterminable and badly described species as the *stellulata* Ellis and Sol and *acropora* Linné, in new senses, while he rejected others, much better described, like *M. cavernosa* Linné, *M. clivosa* Ellis and Sol., because insufficiently characterized. He says of *cavernosa* that the diagnosis "is so imperfect and inadequate that it is absolutely useless" This remark, if true, would apply much better to the diagnoses of *acropora* (see p. 95) and *stellulata*, which he adopts, though in doing so he discards well established later names, based on good descriptions.

Orbicella excelsa Dana. Star Coral.

Astræa (Orbicella) excelsa Dana, Zooph., p. 212, pl. x, fig 16, 1846.
Heliastræa ? excelsa Edw and Haime, Hist Corall., ii, p 478, 1857.
Solenastræa excelsa Verrill, in Dana, Coral Is., ed 1, p 380, 1872; ed. 3, p. 421, 1890
Solenastræa excelsa (pars) Pourtalès, Deep Sea Corals, p 77, 1871.

PLATE XV. FIGURE 4.

Dana's type of this species, in the Boston Society of Natural History, was carefully studied by me a number of years ago, and descriptions were made at that time. The type is apparently slightly beach-worn, but so little that the natural surface of the cœnenchyma and costæ and the summits of the septa are well preserved in most parts, and there is no evidence of post-mortem alteration by infiltration to account for the solidity of the cœnenchyma, referred to by Dana, and which is, indeed, quite remarkable in most parts. The coral is very solid and heavy as contrasted with *O. annularis* or *Solenastræa hyades*.

A fragment, apparently of the same specimen, and which appears to have been used by Dana in describing the details is preserved in the Museum of Yale University. From this the accompanying photograph has been made. (Pl. xv, fig. 4.) The coral grows in irregular, often upright, lobed or gibbous masses, up to 100 to 150^{mm} or more high, but when young it must be encrusting. No. 1729.

The type specimen is so strongly lobed that the lobules in some places look like incipient branches. But these may possibly be due to the coral growing over the tubes of invading bivalves or annelids, though none can be seen without sections. The calicles are more closely crowded on the lobules, especially at the obtuse summits, where they become angular and are separated by thin walls and cellular exotheca. Elsewhere the calicles are nearly circular, scarcely elevated, and separated by exothecal spaces usually about equal to the radii of the calicles, but toward the base often equal to their diameters. The exotheca and walls are very solid in most parts.

The 24 costæ are subequal, thickened, only slightly raised, faintly or almost microscopically granulated; those of adjacent calicles are

So under *Cyphastræa costata* Duncan = *C. oblita* D. and M. (p. 274, op. cit.) he says: "it was named by Duchass. and Mich. two years previously; but they gave so inadequate a diagnosis that their name has no claim to precedence." Yet the latter diagnosis consists of six lines, giving details of the septa, costæ, columella, pali, granulations, etc., that were never mentioned by Linné, Ellis and Sol., and other early writers on whose briefer diagnoses he bases radical changes in accepted nomenclature.

usually separated at the surface by a slight intermediate groove, forming polygonal areas around the calicles. The exotheca is nearly level with the edges of the walls and costæ, flat or slightly concave, minutely granulated or nearly smooth, sometimes slightly vesicular at the surface, but usually almost solid and blended with the costæ and walls; near the tips costæ unite and exotheca is cellular.

In a transverse section, near the surface, the entire partition between the calicles may be perfectly solid, whether thick or thin, but in many cases one or two rows of small rounded or crescent-shaped vesicles can be seen, and sometimes, close to the surface, vesicular dissepiments are visible between the small costæ, while close to the basal margin of the coral the exotheca may be decidedly vesicular, appearing almost like miniature honey-comb in transverse sections. But this basal portion is formed by the thin, down-growing margin, where the new calicles are very short, oblique, and far apart, as in many other corals that have a thin, proliferous margin.

The septa are generally 24, subequal, in three regular cycles; those of the first two cycles are nearly equal in height and thickness; those of the third cycle are thinner and narrower, and generally bend to the right and left in pairs to join the straight septa of the second cycle, usually at a point more than half-way to the columella, and often very near it. The summits of all the septa are narrow and only slightly raised above the walls. The edges are irregularly serrulate, two to four of the basal teeth being the larger. The sides are distinctly granulated. The septa are all thin, but slightly thickened toward the wall, and all are narrowed above the base, so as to leave a cup-like calicular cavity. The columella is small, trabecular, papillose, and often nearly wanting. In transverse sections of some calicles it is solid, and formed by the union of the inner edges of the septa, but in most it is small, porous, trabecular.

Diameter of the calicles 2·5 to 3^{mm}; breadth of intercalicinal spaces, usually 1 to 2^{mm}, sometimes 3 to 4^{mm} or more, near the base.

Origin uncertain, supposed to be West Indies. Several irregular gibbous masses of this species, 3 to 5 inches in thickness, in the Amer. Mus., New York, were found near Osprey, West Florida, cast on the beach after a storm, by R. P. Whitfield (No. 485). I have also seen specimens from Key West.

This species, in the form and structure of its calicles and septa, resembles *Solenastræa hyades*, but the latter has cellular exotheca and rudimentary costæ, characteristic of *Solenastræa*, while this has the costæ and exotheca of *Orbicella*, though the exotheca and walls

become more solid and heavy than usual in that genus, but not more so than in *O. hirtella* and some other species. In both this and *hyades* the septa of the third cycle are well developed and bend toward and join those of the second cycles; in both the septa are thin and but little prominent above the wall; and the columella is usually well developed in both. But *hyades* lacks the radial costal ridges on the exotheca and the bounding polygonal grooves between the calicles. The differences in sections are very marked. However, there are places, near the base, where the exotheca becomes more cellular in this species, and in sections of the under side it is composed of angular exothecal cells separated by thin dissepiments only.

In some respects this species is intermediate between *Solenastræa* and *Orbicella*, and raises the doubt whether a larger series might not compel us to unite the two genera.

I have seen no specimens truly intermediate between this and *hyades*, and as they can be distinguished by structural characters generally held to be generic, it is necessary to keep them separate here, but they may eventually prove to be one species. In that case *Solenastræa* cannot be maintained as a distinct genus.

From *O. annularis* and var. *stellulata* it can at once be distinguished by the thinner and much less projecting septa, and by the wider septa of the third cycle, which do not bend toward and join the septa of the second cycle in those forms.

Orbicella hispidula V., sp. nov.

PLATE XV. FIGURES 3, 3*a*, 3*b*.

Coral an encrusting mass over 125^{mm} across, and from 5 to 20^{mm} thick. The texture is rather solid and heavy, there being much solid exotheca between the calicles, which are rather far apart, the interspaces being mostly equal to, and often exceeding, their diameter.

The calicles are round, regularly stellate, a little prominent, with swollen, sloping, costate rims, much as in those of *O. annularis*, which they resemble in size, though distinctly larger. The septa are in three very regular cycles: the twelve principal ones are wide, nearly equal, all reaching the rather large columella; their edges are perpendicular and finely, sharply serrate, with slender rough teeth, which extend also over their prominent, obtuse or subtruncate summits, giving them a rough appearance under a lens; their surfaces are also rough or hispid with numerous conical grains. The septa of the third cycle are narrow, straight, and usually reach about halfway to the columella.

The costæ are thick, not very high, meeting or inosculating between the calicles, and covered with a single row of small, slender, rough spinules. The columella is well developed, formed of contorted trabecular processes, and often having a small pit in the center and a few erect spinules, similar to the slender, rough, paliform teeth that often (but not regularly) stand at the base of some of the 12 larger septa.

In sections the walls are very thick and nearly solid. The endothecal dissepiments are small, thin, irregularly convex or flat above. The calicles are not filled up below, or only slightly encroached upon, by a deposit between some of the septa. Diameter of the calicles 3 to 3.5^{mm}; distance between them mostly 2 to 4^{mm}, often more.

Florida Reefs (Maj. E. B. Hunt), Yale Museum, No. 98. Near Nassau, N. P. (coll. R P. Whitfield), Amer. Mus., New York.

This has the general appearance of *O. annularis*, but with calicles larger than usual and decidedly farther apart. The walls and exotheca are much thicker and more solid, and the endotheeal cells are fewer and less regular. The sharply spinulose and hispid septa and costæ are also characteristic. The exotheeal deposits are nearly as solid as in *Oculina.*

A Nassau specimen, in the American Museum, is an irregular rounded mass, about five inches in diameter and three to four thick, with a lobulated surface. The coral is heavy and solid; the surface of the cœnenchyma is spinulose; the costæ well developed. The calicles are more variable in size than in the type, in some places being one-half smaller and closely crowded. Coll. R. P. Whitfield.

Orbicella Braziliana Ver., nom. nov.

Orbicella cavernosa Quelch, Voy. Chall., xvi, p. 106, 1886 (*non* Lam.).

I propose this name for the form taken by the Challenger, off Barra Grande, Brazil, in 30 fathoms.

According to Quelch it forms rounded masses two feet in diameter. Its exotheca is so vesicular as to partly hide the costæ; the septa are uniformly thickened. As he refers it to *cavernosa*, it should have large calicles with four cycles of septa. Since nearly all the other Brazilian corals are distinct from the West Indian, the locality and depth where this was found, as well as the characters mentioned, indicate a species distinct from the common West Indian reef species.

Orbicella cavernosa (Linné) Ver.

Madrepora cavernosa Linné, Syst., ed. xii, p. 1276, 1766. Esper, Fortsetz. i, p. 18, pl. xxxvii, 1797.

Madrepora radiata Ellis and Sol., Zoöph., p. 169, pl. xlvii, fig. 8, 1786.

Favia cavernosa Oken, Lehr. Naturg., p. 67, 1815.

Astrea radiata and *A. argus* Lam., Hist. Anim. sans Vert., ii, pp. 258, 259, 1816; ed. 2, p. 404. Lamouroux, Encyl. Meth., pp. 57, 131, pl. xlvii, fig. 8, 1824. (Reprint of plate of Ellis and Sol.)

Astrea cavernosa Schweig., Naturg., p. 419, 1820. Edw. and Haime, Brit. Fossil Corals, p. xxxix, 1850.

Astrea (Orbicella) argus and *A. (O.) radiata* Dana, Zoöph., pp 206, 207, pl. x, figs. 1*a*, 1*b*, 1846.

Astrea cavernosa, *A. radiata*, and *A. conferta* Edw. and Haime, Ann. Sci. Nat., vol. x, pl. ix, figs. 1, 1*a*, vol. xii, pp. 97, 101, 102, 1850.

Heliastraea conferta, *H. cavernosa*, and *H. radiata* Edw. and Haime, Hist. Corall., ii, pp. 460, 468, 470, 1857.

Orbicella cavernosa Verrill, Bull. Mus. Comp. Zool., i, p. 47, 1864. Proc. Boston Soc. Nat. Hist., x, p. 323, 1865. These Trans., x, p. 558, 1900. Pourtalès, Florida Reefs, p. 76, 1871. Quelch, Reef Corals, Chall. Exp., xvi, pp. 12, 106, 1886.

Orbicella radiata (pars), Gregory, Quart. Jour. Geol. Soc., li, p. 270, 1895.

Orbicella cavernosa Vaughan, op. cit., p. 27, 1901 (Syn. and description).

Vaughan adds to the synonyms the following fossil forms described by Duncan: *A. endothecata*, *A. cylindrica*, *A. antiguensis ?*, *A. intermedia*, *A. antillarum ?*, *A. brevis*.

Much of the confusion in regard to the name of this species is due to the fact that it was generally described and figured from badly beach-worn specimens by the earlier writers. Such specimens have the septa and calicles worn away and the hard exotheca thus becomes prominent around the excavate calicles, so as to greatly change the appearance of the coral. Another cause is the rather wide variations in the size of the calicles.

The normal or average specimens have the calicles about 6 to 8^{mm} in diameter, but occasionally a specimen occurs in which part or all of them may be 9–10^{mm}, or rarely, even 11^{mm} in diameter. Sometimes, on crowded parts of large specimens, the diameter may be only 4 to 5^{mm}. The degree of elevation of the calicles is also more or less variable on a single specimen.

The calicles may be pretty close together, where crowded, but in other cases they are separated by spaces of 4 to 6^{mm} or more. The costæ are usually well developed as denticulated, rounded, radial ribs, usually 48 in number.

The septa are generally about 48, arranged in four regular cycles, but several of those of the last cycle are often rudimentary or lacking, reducing the number to 40–44. They differ in breadth and

thickness according to the cycles; those of the last cycle are very thin and often bend toward and join those of the third cycle. The principal septa are exsert, denticulated, and thickened at the wall. The columella is usually well developed and broad. The paliform teeth are distinct, but not very prominent. It sometimes forms hemispherical masses four to five feet or more in diameter.

This species appears to be rare at the Bermudas, and probably occurs only on the outermost reefs. The only specimen seen by me from there was from near the North Rocks. (Centennial collection.) It is a hemisphere about 11 inches in diameter, of the typical form. It is common on the Florida reefs and throughout the West Indies. Bahia, Brazil; (Yale Mus.);=var. *hirta*, nov., with elevated corallites; roughly serrate, thin costæ and septa; calicles deep, 5-6^{mm} broad; septa narrow, perpendicular within, usually 40–44. Pl. xxxiii, figs 2, 2*a*.

Orbicella aperta Verrill

Heliastræa aperta Verrill, these Trans., vol. i, part 2, p 356, 1868

PLATE XXXIII FIGURES 1, 1*a*

This species is remarkable, not only for its thin, lacerately toothed, and strongly exsert septa, but also for its very thin walls and abundant and very cellular exotheca, so that the coral is very light, as compared with *O. cavernosa* and *O. annularis*. There are usually four cycles of septa, those of the third being very narrow.

The costæ are rather feeble and those of the fourth cycle are rudimentary or lacking.

The calicles average somewhat smaller than in *O. cavernosa*, but decidedly larger than in *O. annularis*. They are about 6 to 8^{mm} in diameter. The interseptal loculi are deep and wide. The columella is rather wide, but is loosely trabecular and lamellar.

Having recently reëxamined the original type of this species, in comparison with large series of *O. cavernosa*, I must adhere to my original opinion that it is a distinct species.

Mr. Gregory (op. cit., p. 271) thinks it is only a form of *O. cavernosa*. Mr. Vaughan (op. cit., p. 31) thinks it a strongly marked variety, if not a distinct species.

Both species occur on the coast of Brazil, in shallow water, and apparently in the same region, but perhaps not in the same stations.

The type was from the Abrolhos Reefs, Brazil, in three to four feet of water. According to Mr. R. Rathbun, it is abundant in the Bay of Bahia, as at the Island of Itaparica, where it is collected to be burned into quicklime, with other corals. No. 1518.

Solenastræa hyades (Dana) D. and Mich.

Astræa (Orbicella) hyades Dana, Zoöph. U. States Expl. Exp., p. 212, pl. x, fig. 15, 1846.

Heliastræa ? hyades Edw. and Haime, Hist. Nat. Corall., ii, p. 478, 1857.

Solenastræa Bournoni Edw. and Haime, Ann. Sci Nat., xii, p. 121, 1850; Hist. Corall., ii, p 497, 1857.

Solenastrea hyades + ? S. micans + ? Heliastræa abdita Duch. and Mich., Corall Antill., pp. 76, 77, pl. ix, figs. 9, 10 (not 10 and 11, as in text), 1860. (On pl. ix there are two figures numbered 9, one by error for 10.)

Solenastræa hyades Verrill, in Dana, Coral Islands, ed. 1, p. 280; ed. 3, p. 421, 1890.

Solenastræa excelsa (pars) Pourt., Deep Sea Corals, p 77, 1871

?? Solenastræa stellulata (pars) Gregory, Quart J. Linn. Soc., li, p 278, pl. x, figs, 4*a*, 4*b*, 1895 (*non* Ellis and Sol.).

PLATE XV FIGURES 5, 5*a*.

The types of *Orbicella hyades* Dana and *O. excelsa* Dana are in the Boston Society of Natural History, where I carefully studied them several years ago.

Very similar specimens of *hyades*, from St. Thomas, attached to stones, are in the Yale Museum. These form convex masses, encrusting and thin at the margins, where the newly formed calicles are very oblique. (Pl. xv, fig. 5.) No. 1580*b*.

Calicles circular, or nearly so, mostly 3 to 3.5mm in diameter; borders generally distinctly elevated above the exotheca, often to the height of .5 to 1mm. Younger and smaller calicles, 1.5 to 2.5mm in diameter, are scattered between the full grown ones. In the middle of the convex summit the calicles are so crowded that the walls are in contact, and here they often become angular by crowding, and when not in contact their edges may not be elevated. On other parts they may be separated by intervals of 2 to 3mm or more. The walls are very thin. The costæ are thickened and roughly minutely serrulate; they are very narrow and mostly confined to the wall, never extending across the exothecal spaces, when these occur. The surface of the exotheca is smooth or vesicular; in sections the exotheca is openly vesicular.

Septa 20 to 24, mostly 24 in mature calicles; 12 extend to the columella; those of the third cycle are also wide, but thinner, and most of them bend toward and join the larger ones about midway between the wall and columella. The septa all become thin and curved toward the columella, but thickened at the wall; the summits are narrowed and rather prominent above the walls; inner edge irregularly and roughly serrulate, especially distally; sides

roughly granulated. Paliform lobes small and thin. Columella usually rather small and loose; formed of small twisted processes from the inner edges of the septa, but variable in size.

Thickness of the larger mass from St. Thomas, about 50^{mm}; diameter, 125^{mm}; diameter of calicles mostly 3 to 3.5^{mm}; rarely 4^{mm}.

This species is found on the Florida Reefs and throughout the West Indies. It has not been found at the Bermudas. St. Thomas (coll. C. F. Hartt, Yale Mus.). In the Amer. Museum, New York, there is a large turbinate mass, 12 to 14 inches in diameter and about 10 inches high, from Jamaica.

Mr. Pourtalès put *Madrepora pleiades* Ellis and Sol. and *M. stellulata* E. and H., as doubtful synonyms of this species. The original descriptions and figures of both those species are too imperfect for definite determination, having been based on badly beach-worn specimens, superficially examined, and rudely figured.

Mr. Gregory adopted *stellulata* as the name of this or an allied fossil species, and put *hyades* under *Orbicella acropora.* Yet Dana's description and figures are vastly better than those of Ellis and Solander. It seems incredible that such an error should have been made in so recent a work. The *stellulata* of Dana (ex. Ellis and Sol.) is an *Orbicella*, and is quite likely to be the same species named *stellulata* by Ellis and Sol. Surely Dana had as good reasons for his opinion as Gregory had. Therefore, it seems best to follow Dana's determination of that name, as being the prior one, and also because it eliminates a very doubtful and useless name. See p. 97.

As for *pleiades* (Ellis and Sol.), that is so doubtful a form that it has been interpreted in many different ways. According to Edw. and Haime it is the same as their *Heliastræa acropora*, and this seems to be the prevailing opinion. But the description and figure would apply just as well or better to certain East Indian species of *Solenastræa*. Hence it is best to eliminate the name by considering it the same as *Solenastræa pleiades* (Dana). There is no reason for thinking that it was a West Indian coral.

The fossil *Solenastræa stellulata* of Gregory may not be this species, for it has larger costæ, and much thicker and more solid exotheca and walls, while the septa of the third cycle are represented as narrow and straight. The figured sections resemble more nearly some of those seen in *Orbicella excelsa*, to which I am inclined to believe that his figured specimens belong.

The *Madrepora hyades* Ellis and Sol. was a *Siderastræa*, and has no relation to Dana's species.

Plesiastræa Goodei Verrill.

These Trans., x, p. 553, pl. lxvii, fig. 1, 1900.

In addition to the type, I have seen another fine Bermudian specimen of this species, in the American Museum, New York, collected on a reef in Bailey Bay, at the depth of about 20 feet, by Mr. R. P.

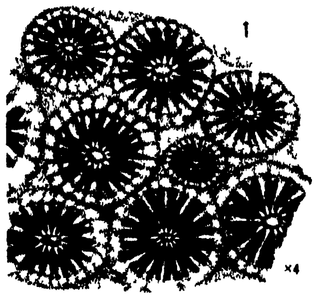

Figure 1.—*Plesiastræa Goodei* Ver. Part of type. × 4.

Whitfield, in 1897. It is about 10 inches in diameter, in the form of a somewhat irregular and lobulated hemisphere.

The same museum has two smaller specimens, in the form of subconical masses, 3 to 4 inches in diameter, obtained in the Bahamas by Mr. R. P. Whitfield. These also agree very closely with the type in all essential points, but some of them have the calicles more crowded, smaller, and subangular in some areas.

Stephanocœnia intersepta (Esper.) Edw. and H.

Madrepora intersepta Esper, Pflanz., Forts., I, p. 99, pl. lxxix, 1797.

Astrea intersepta Lam., Hist Anim. s. Vert., ii, p. 266, 1816; ed. ii, p. 417, (*non* Dana).

Stephanocœnia intersepta and S. Michelini Edw. and Haime, Ann. Sci. Nat., x, pp. 300, 301, pl. 7, fig. 1–1*b*, 1849; Hist. Corall., ii, pp. 265, 266, 1857. Gregory, Quart. Jour. Geol. Soc. London, li, p. 276, pl. xi, figs. 5*a*, 5*b*, 6, 1895. Vaughan, op. cit., p. 20, 1901.

Antillastræa spongiformis Duncan, Revision Mad., p. 108, 1884, (t. Gregory from type).

The recent specimens that I have seen from the West Indies agree better with *S. Michelini*, which is, perhaps, only a massive variety of *S. intersepta*.

The American Museum, New York, has a large lobulated mass, over a foot in diameter, from Jamaica. This has six large rounded lobes, the largest about 6 inches in diameter, rising from a common basal mass.

The septa are much exsert, narrow, entire, and with the inner edge perpendicular, leaving a narrow central cup. The columella is

small, lamellose, sometimes with a minute central tubercle. The calicles vary considerably in size, being smaller and more crowded, sometimes angular, at the bases of the lobes. The distance between them is also variable. The diameter of the calicles varies from 1.75 to 2.5^{mm}, but most of them are about 2 to 2.5^{mm}.

Throughout the West Indies, but not recorded from Florida nor from the Bermudas. Fossil in the elevated reefs of many of the West Indies.

Cyphastræa nodulosa Ver , sp. nov.

PLATE XXXI. FIGURES 2, 2*a*, 2*b*.

The coral forms small nodular masses, about 55 to 65^{mm} in diameter and 35 to 45^{mm} high, consisting of numerous small, rounded or short, subclavate nodules, rising like incipient branches from a common thick, irregular base. It is compact and heavy, with small circular calicles.

The corallites, where not much crowded, project distinctly above the cœnenchyma and have a rather thin rim and feebly costate wall. In other parts they are not at all raised and the calicles may be immersed in the cœnenchyma, which is very compact, with the surface sometimes covered with low rounded granules, in radial costal lines, but in other parts it is often nearly smooth.

The calicles are small, but rather open and deep, owing to the narrow septa. They are mostly from 1.25 to 1.50^{mm} in diameter, and are often separated by spaces of 1 to 2^{mm}.

The septa are in three cycles, consisting of 12 narrow, subequal ones, of the two first cycles, alternating with 12 very narrow or rudimentary ones of the third cycle. These last are often lacking, or invisible without a lens, in some of the systems.

The larger septa are narrow, usually much exsert, with an obtuse, serrulate apex, and a perpendicular inner edge, which is finely serrulate or subentire; their proximal portion is very thin and denticulate. The paliform tooth is very small, but distinct, papilliform. The columella is small, minutely trabecular with one or more minute papillæ on the surface.

In sections the walls and exotheca are often entirely compact, especially near the surface, but in other parts there may be exothecal cellules; the septa are thin and divided into numerous fine trabeculæ; the dissepiments are numerous, very thin, nearly horizontal, often subtabular; columella loosely trabecular.

Bahamas,—R. P. Whitfield; three specimens, No. 542, Amer. Mus.

Family **Stylophoridæ** Ver.

Stylophorinæ Edw. and Haime, Hist., ii, p. 132, 1857.
Stylophoridæ Verrill, these Trans., i, p. 514, 1867.

Corals mostly branched, often encrusting when young; sometimes lobulate or massive, increasing by budding. Calicles small, stellate, immersed, usually separated by rather abundant exothecal cœnenchyma, not entirely solid, and often granulated or striated on the surface. Septa generally either 10 or 12. Loculi between the septa not filled up below by stereoplasm. Columella various. Polyps exsert in expansion, usually with 12, 20, or 24 tentacles.

This family is chiefly Indo-Pacific, where it is represented by numerous species of *Stylophora*.

Madracis decactis (Lym.) Ver.

Astrea decactis Lyman, Proc. Boston Soc. Nat. Hist., vi, p. 260, 1859.
Madracis decactis Verrill, Bull. Mus. Comp. Zool., i, p. 45, 1864. Pourtalès, Deep Sea Corals, pp. 28, 67, pl. vii, figs. 1–4, 1871. Quelch, op. cit., p 53, 1886. Gregory, op. cit., p. 258, fig. 1, 1895. Verrill, these Trans., x, p. 554, pl. lxvii, figs. 8, 10, 1900.
Reussia lamellosa Duch. and Mich., Corall. Antill., p. 339 [62], pl. ix, figs. 7, 8 (as numbered on plate, not 8, 9 as in text), 1860 (*non Stylophora mirabilis*, p. 61, pl. ix, figs. 6, 9, as numbered, not 6, 7, as in text).
Stephanocœnia dendroidea Duncan, Quart. J. Linn. Soc., xix, p. 432, 1863, *non* Edw. and H. (t. Gregory).
Axhelia decactis Vaughan, op. cit., p. 8, 1901.
? *Madracis asperula* Moseley, Voy. Chall., ii, p. 182, 1880, from S. W. Bank, off Bermuda, 30 fath. (? *non* E. and Haime).

This species occurs in thin crusts, irregularly massive, nodose or lobulated, and also both in slender, and in short, stout, branched

2. 2a.

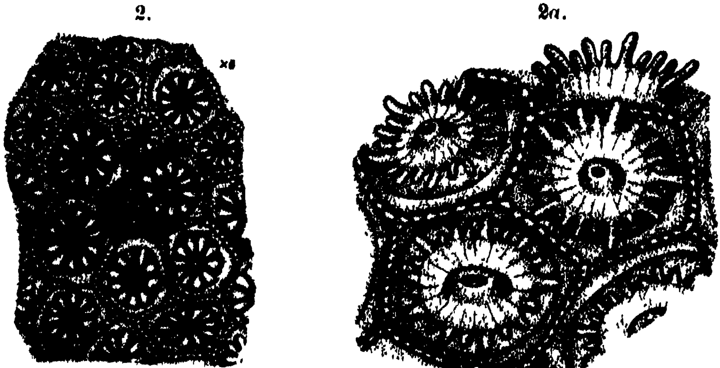

Figure 2.—*Madracis decactis* (Ly.) Ver. Part of the dry coral. ×6.
Figure 2a.—The same, with the polyps expanded. ×12.

forms. The animals have been described both by Pourtalès and myself and were figured by me. (These Trans., x, pl. lxvii, fig. 10.)

The general color of the coral, in life, is yellow, yellowish brown, or purplish brown; disk often purplish, with white radii, forming a star around the mouth; lips and tips of tentacles white.

As stated by Pourtalès, and figured by me in 1900, there are three pentamerous cycles of tentacles (5, 5, 10) and two equal cycles of septa (5, 5). Sometimes a few rudimentary septa of the third cycle appear. One Bermuda specimen has several very large calicles, with 20 to 30 regular septa. Pl. xiv, fig. 6.

Duncan (Revision, p. 45, 1884) united *Axohelia* E. and H. with this genus, under the name of *Madracis*. Several others have done the same. Vaughan, however (op. cit., pp. 5, 8), proposes to unite them under the name *Axhelia*. Both names are of the same date. Therefore, if they are to be united, Duncan's choice of names has precedence and should be upheld. Kent gave it the name *Pentalophora*, as a substitute for *Reussia* (preoccupied).

However, these genera seem to me sufficiently distinct. *Axohelia* lacks the definite bounding ridges of the calicles and the granulated exotheca. Its exothecal surfaces are smooth or striated, and show no partitions between the calicles.

Perhaps the *Madracis* taken by the Challenger, on the S. W. Bank, in 30 fathoms, and recorded by Moseley as *M. asperula*, was *M. decactis*, which is not uncommon on the reefs in shallow water.*

Some of the lobulated or branched clumps are 6 inches or more high and broad, but they are very brittle and not often obtained entire. Several large and fine specimens of this kind are preserved in the American Museum, New York, as well as a slender, dichotomously branched variety. Both forms occur at the Bermudas.

It is found on the Bermuda Reefs and throughout the West Indies. It also occurs as a fossil in the raised reefs of many of the islands Gregory (op. cit.) records it as a Pleistocene fossil from Bermuda, (probably from Nelson's collection in Geol. Soc., London). The age of such Bermuda fossils, from the "beach rock," is however very uncertain, but they are probably postpliocene, or post glacial.

Pourtalès was evidently wrong in referring to this species the *Stylophora mirabilis* Duch. and Mich. Probably he was misled by errors in the numbering of the plate (ix). On that plate there are two figs. 9. One of these is a misprint for 7, and represents the enlarged calicles of the *mirabilis* (fig. 6), and shows 18 to 24 equal septa. The other fig. 9 is a *Solenastræa* and should have been 10. Other errors in numbering occur on this plate.

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* Pourtalès (Deep Sea Corals, p. 27, pl. vii, fig. 4, and in later papers) records *M. asperula* Edw. and Haime, from the West Indian region, in 36–280 fathoms.

Axohelia Schrammii ? Pourt., Mem. Mus. Comp. Zoöl., iv, p. 41, pl. viii, fig. 2, 1874.

PLATE XVIII. FIGURES 3, 4

Coral small, arborescently branched, the terminal branches slender, tapered, acute; the larger stems are about 12–15^{mm} in diameter. The coral is hard; the cœnenchyma is abundant in the larger branches, and its surface is covered with long, curved septocostal striæ, between which it is microscopically granulated, but there are no lines of granules bounding the calicinal areas, as in *Madracis*. Septa 10, equal, narrow, slightly prominent. Columella small, solid, tubercular.

Several specimens are in the Museum of Yale Univ. They are attached to pieces of a cable. (Coll. H. A. Ward.) Guadaloupe (Pourt.).

Its calicles agree better with *A. myriaster* (?) Pourt., pl. viii, fig. 3, which may not be distinct. No. 5662.

Family **Oculinidæ** Edw. and Haime, restr.

Oculinidæ Verrill, these Trans., i, p. 514, 1867.

Corals generally branched, increasing by budding. Calicles round, stellate. Septa 12 to 48 or rarely more, unequal, usually entire or subentire; pali often present. Interseptal loculi become filled up and obliterated below by a solid endothecal deposit, or stereoplasm. Usually a solid cœnenchyma, with curved costal striations on its surface, separates the calicles, especially in the older parts of the coral, where it is often abundant.

Madrepora (Linné) Oken, restr. (*non* Lam.) Type, *M. oculata* Linné.

Madrepora (*pars*) Linné, and of all writers before 1801 (not of Lamarck, 1801, nor of 1816; not of Ehrenberg, 1834).

Matrepora, restricted (altered spelling), Oken, Lehrb. Naturg., p. 72, 1815.

Oculina (*pars*) Lamarck, Hist. Anim. sans Vert., ii, p. 284, 1816.

Amphelia and *Lophelia* Edw. and Haime, Comptes-rendus, xxix, p. 69, 1849.

Amphihelia and *Lophohelia* Edw. and Haime, Hist. Nat. Corall., ii, pp. 116, 118, 1857.

Lophohelia Pourtalès, Deep Sea Corals, p. 25.

It is well known that Linné (Syst. Nat., ed. x, 1758) did not include in his genus *Madrepora* any recognized species of the Lamarckian genus of that name, but placed by an error *M. muricata* (in which several species were included) in his genus *Millepora*, although it agrees with his definition of *Madrepora*. He corrected this mistake in the ed. xii, p. 1279, where *Madrepora muricata* appears. Pallas, (Elenchus, p. 327, 1766) had previously made the same correction.

No valid attempt to subdivide the great genus *Madrepora* seems to

have been made until 1801, when Lamarck (Syst. Anim., pp. 369–375) divided it into eight genera.* Unfortunately he restricted the name *Madrepora* to the group that included *M. muricata* and *M. porites* Pallas. The latter was made the type of *Porites*, by Link, 1807.

The next restriction of the name was by Oken (Lehrb., 1815), who established a number of additional generic subdivisions and restricted *Madrepora* (which he spelled *Matrepora*†) to four species, one of which, *M. ramea*, became the type of *Dendrophyllia* Bv., 1830; the others were earlier (1816) placed in *Oculina* by Lamarck. One of these (*M. oculata* Linné), which is the long-known and officinal "white coral" of the Mediterranean, the "*Madrepora vulgaris*" of Tournefort, may well be taken as the true type of *Madrepora*, not only on account of Oken's restriction, but also because of the rule, advocated and followed by many naturalists of the Linnæan period, that the type of a genus should be the most common or officinal and well-known species, if such were included. Certainly *M. oculata* would answer well to this requirement, and so would *M. prolifera*.

Moreover, in following the principle of elimination, this was one of the very last of the determinable Linnæan species to receive a special generic name (1849). *M. prolifera*, the second species of Oken, and the type of *Lophohelia* E. and H., is now made congeneric with *M. oculata*.

Therefore, it appears that *oculata* should be taken as the true type of the restricted genus *Madrepora*, if the Lamarckian nomenclature must, in this case, be abandoned, as argued by Vaughan‡ and other recent writers.

* These genera are as follows: *Cyclolites*, p. 369; *Fungia*, p. 369, *Caryophyllia*, p. 370; *Madrepora*, p. 371; *Astrea*, p. 371; *Meandrina*, p. 372; *Pavona*, p. 372; *Agaricia*, p. 373.

† That Oken, in using *Matrepora*, did not intend it as a new name, but only as a corrected spelling of *Madrepora*, is proved by the fact that in citing the Linnæan names of species under various genera, he invariably quotes them as "*Matrepora*" or "*Mat.*" of Linné. The generic divisions of *Madrepora* proposed by Oken are as follows:—*Astrea*, p. 65 = *Astrea* (*pars*) Lam., 1801; *Acropora*, p. 66; *Turbinaria*, p. 67; *Faria*, p. 67; *Pectinia*, p. 68 = *Meandrina* Lam., 1801; *Undaria*, p. 69 = *Agaricia*, Lam., 1801; *Mycedium*, p. 69; *Meandra*, p. 70; *Matrepora*, p. 71 (includes 4 species, viz.—*M. ramea*, *M. prolifera*, *M. virginea*, *M. oculata*); *Galaxea*, p. 72 (with 4 species); *Mussa*, p. 73 (2 species); *Fungia*, p. 74, 2 sp. = *Fungia* Lam., 1801.

Probably Lamarck's Systeme Anim. sans Vert., 1801, was not known to Oken, for he makes no reference to it. The coincidences in some of the names were probably due to the influence of the older specific and polynomial names. Neither does he refer to Link's work of 1807.

‡ Samml. Geol. Reichs-Mus., ii, p. 68, 1901.

Ehrenberg, in 1834, definitely restricted *Madrepora* to a group that included *Porites* and *Montipora*, while he called the Lamarckian genus, *Heteropora*. His nomenclature cannot be followed: 1st, because *Porites* had been separated and named by Link, 1807, and Lamarck, 1816; 2d, no recognizable species of *Montipora* was included in *Madrepora* by Linné, ed. x; 3d, *Heteropora* had previously been used by Blainville for a bryozoan; 4th, Oken's restriction has priority.

For several reasons, it seems to me doubtful whether, under the rules of priority usually accepted, it will not be thought by many unnecessary to abandon the name *Madrepora* for the *muricata*-type, as restricted by Lamarck, for the following reasons:—

1st.—By Linné and all other writers of his period *Madrepora* was used as a collective name for all corals of the order *Madreporaria* It was rather an order or suborder than a genus, and therefore it seems useless to apply the rigid modern rules of priority to such a group name.

2d.—*Madrepora muricata* L. had been referred to *Madrepora* by Linné, as *M. spinosa*, before the date of ed. x (Mus. Tessin., p. 118), and its reference to *Millepora* in the later work was clearly an error speedily corrected.*

3d.—Linné, in ed. xii, gave his more mature and corrected views as to his own genera. Therefore, for the discussion of *generic* nomenclature, it might be better not to go back of that edition.

4th.—It is possible that at least one of his species in the ed. x, viz. *M. polygama*, No. 28, p. 795, belongs to the Lamarckian genus *Madrepora*, for it was described as having cylindrical, 12-rayed calicles, though the larger cells, mentioned by him, were probably parasitic barnacles. This species is probably indeterminable. It may have been a *Montipora*.

Should *M. polygama* L. be hereafter positively identified as a species congeneric with *M. muricata*, as is possible, this fact alone would, perhaps, make valid Lamarck's restriction of the name *Madrepora* in the opinion of many. Such a determination is not impossible, though this species has hitherto remained very doubtful.

In the meantime many persons will doubtless prefer to take the more recent and radical course, and apply some other name to Lamarck's *Madrepora*. Vaughan (op. cit., p. 68) has adopted *Isopora*, first used under *Madrepora* as a subgeneric name by Studer,

* By another error he referred the "red coral" (*Corallium rubrum*) to *Madrepora* (*M. rubra*, p. 797).

in 1878. Under this name he included the whole extensive genus. This name would surely be a very inappropriate one, so far as its significance is concerned, nor would Studer's definition apply to the genus, as a whole. Moreover, it may become necessary to separate *Isopora*, in Studer's sense, as a genus. I believe that *Acropora* Oken has much better claims for adoption in place of *Madrepora*. (See below.)

As restricted above, the genus will include branching oculinoid corals that increase by lateral or marginal buds; with turbinate corallites, and deep cup-like calicles. The cœnenchyma is usually abundant and solid in the main branches and trunk, but may be very scanty in the terminal branches. Pali lacking. Septa broad, entire. Columella small or lacking.

Besides the type and *M. virginea* (L.), which is considered identical with it by Edw. and Haime, the genus *Madrepora*, as restricted above, would include the following species and others:

M. venusta E. and H., Australia.

M. exigua (Pourt., as *Lophohelia*). Off Florida, 36–79 fathoms.

M. Carolina (Pourt., as *Lophohelia*). Off Havana.

M. prolifera (L.). Boreal and Arctic, and in deep waterto Florida.

M. infundibulifera Lam. (as *Oculina*). Kent, fig., 1871 ; Quelch, p. 53. Ternate.

M. subcostata (Edw. and H.). Locality unknown.

M. Defrancei (E. and H.). Pliocene of Europe.

M. candida (Moseley, 1881, as *Lophohelia*). Off Sombrero I., 450 fathoms.

M. tenuis (Moseley, 1881, as *Lophohelia*). Philippine Is.

M. anthophyllites (Ellis and Sol.) ; E. and Haime, as *Lophohelia*. E. Indies. Type is in Hunterian Mus., t. Young.

M. ornata (Duncan). North Atlantic.

Family **Eusmillidæ** Verrill, 1866.

Eusmillinæ (pars) and *Euphylliaceæ* Edw. and Haime, Hist. Corall . ii, pp 144 and 188, 1857.

Corals dichotomous, glomerate, or massive, often meandriniform or astreiform, increasing chiefly by fission, complete or incomplete. Septa entire or nearly so, sometimes very finely serrulate. Paliform lobe, feeble or lacking. Columella variously developed, often lacking. Zoöids actiniform, much exsert in expansion.

Eusmilia aspera (Dana) Edw. and Haime

Euphyllia aspera Dana, Zoöph U. S. Expl. Exp., pp. 164, 720, pl. ix, fig. 7, 1846.

Eusmilia aspera Edw. and Haime, Hist. Corall , ii, p 187, 1857.

Eusmilia Knorrii Edw. and Haime, Mon. Aster., Ann. Sci. Nat , Zoöl., ser. 3, x, p. 265, pl. v, fig. 2, 1849.* Gregory, op. cit., p 261, 1895 Vaughan, op. cit., p. 18, 1901.

Dana's figured type is in the Yale Museum. The description is good and the outline figure is very correct. It represents a branch with three calicles, broken from a larger specimen, also in the Yale Museum. No. 466.

8.

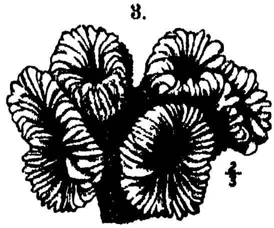


Figure 8.—*Eusmillia aspera* (Dana). Part of type, ⅔ natural size.

This specimen has the columella well developed in most of the calicles, though small in some of the younger ones. It consists of variously contorted thin laminæ. The costæ are alternately large and small; the larger ones are thick, angular, uneven or lobed, often cristate near the calicles, and irregularly dentate, with small rough teeth.

There can be no doubt of its identity with *E. Knorrii* E. and H., as these authors themselves admitted in their Hist. Corall., 1857. Therefore it seems strange that both Gregory and Vaughan should have tried to restore this discarded later name without any legitimate reason.†

* Gregory (op. cit., p. 261) quotes the date of *Knorrii* Edw. and Haime, Monog., as 1848. Edw. and Haime themselves quote it in Hist. Corall., ii, 188, as 1849 Gregory also quotes *aspera* Dana as 1848. It is well known that his report was published in 1846. But Gregory repeats this wrong date under various other species, so that we cannot reckon it a typographical error. Edw. and Haime give the date as 1846, correctly.

† Gregory's statement that Dana's species was "so inadequately diagnosed that there can be no certainty regarding it," is obviously erroneous. Edw. and Haime certainly were able to recognize it. The figure and description are far better than those of most corals before Dana's work. Moreover, the type, duly labeled, was in the same case and on the same shelf with other specimens that Mr. Gregory examined when he made his very hasty visit to the Yale Museum, (see p. 145). He could have studied it and various other types of Dana, had he taken the necessary time.

Family **Mussidæ** Ver.

Fasciculate, glomerate, massive, and sometimes simple corals, increasing by fission, and with strongly dentate or spinose septa, without a paliform lobe. Calicles generally large, sometimes united in short or long series, but always with distinct centers and radial septa. Polyps much exsert in expansion, actiniform, with large tentacles.

Isophyllia Edw. and Haime (emended*). Rose Corals "Cactus Corals."

Mussa (pars) Dana, Zooph., p. 173, 1846.

Symphyllia (pars) Edw. and Haime, Ann Sci. Nat., xi, p. 236, 1849; Corall., ii, p. 373, 1857; Duch. and Mich., Corall. Antill., p. 69, 1861.

Isophyllia Edw. and Haime, Pol. Foss. Paleoz., p. 87, 1849; Hist. Corall., ii, p. 974, 1857.

Mycetophyllia (pars) Edw and Haime, Compt.-rend., xxvii, p 491, 1848, Hist. Corall., ii, p. 375, 1857 (2d section).

Lithophyllia (pars) Duch. and Mich., Corall. Antill., pp. 67, 68, 1860), young, (*non* Edw. and Haime).

Ulophyllia (pars) Bruggmann, Ann and Mag. Nat. Hist., Oct., 1877, p. 312.

Symphyllia (pars) Duncan, Revision, Journ Linn. Soc., xviii, p. 91, 1884.

This genus, as now restricted, includes a group of *Mussidæ* in which the calicles, when mature, are large and open, isolated or in series, with numerous large, strongly serrate septa; the serrations are either subequal, or else larger toward the columella, which is

* The genus, as here limited, corresponds with that of Edw. and Haime of the same name, plus certain forms referred by them to *Symphyllia* and to *Mycetophyllia* (*M. Danaana* E. and H., Hist, p. 377, pl. D4, fig. 2). Most of their species of *Symphyllia* are simply *Mussæ* with coalescent walls. So *Symphyllia* and *Isophyllia* cannot be united in bulk, as was done by Duncan and by Pourtalès, under either name. *Symphyllia* should be dropped and its species should be distributed to *Mussa* and *Isophyllia*, according to their structure. But if retained at all, even as a subgenus, it should be used for the typical East Indian forms, like *S. radians* E. and H.

I cannot distinguish in *Mycetophyllia Danaana* E. and H. any characters apart from *Isophyllia*.

Nor can I find any good reason for separating *Ulophyllia*, or at least the typical species, widely from *Symphyllia* and consequently should consider such species as nearly related to the massive *Mussæ*. The only difference from *Symphyllia*, as stated by Edw. and Haime, consists in the denticles of the septa being larger toward the columella, while in the latter the distal ones are the larger. But I have studied specimens of *crispa*, the typical species, (see p. 131) and have found the teeth variable in this respect; in some calicles the larger teeth were distal, in others proximal, in one specimen, and these differences may be observed on the septa of a single calicle. The fossil forms of Edw. and

formed of loosely arranged processes of the septa. The costæ are distinct, but narrow, serrulate ribs. The primary collines are radial, dividing the margin, at one stage of growth, into several (normally six) calicinal lobes; they may be solid, with a simple wall, or they may be double, with intermural exotheca and a groove on the summit. These variations often occur on one specimen. The union of the walls may also be so incomplete that they stand separately in many parts of some examples. The calicles vary greatly in size, form, and degree of union into series, even on one specimen of most species, when full grown.

The relative number and closeness of the septa, the granulation of their surfaces, the general character and size of their serrations, and the character of the costæ and their serrations afford much better characters for specific distinctions. But all these vary more or less, so that a large series must be studied with great care before one can reach an intelligent opinion as to the limits of any of the species of this group.

The figures that have been published of the species of this genus are entirely unsatisfactory. Even the beautiful lithographic figures drawn by Sonrel for Professor L. Agassiz (see Pourtalès, Florida Reefs, pl. vii) are by no means correct enough for systematic purposes.* Photographs alone can properly represent corals of this character. After a most careful study of the large series of *Isophylliæ* in my own collections and others that are in the Yale Museum, the Museum of Comp. Zoölogy, the American Museum, New York, and several other large collections, I am convinced that far too many species have been recognized. In the Bermudian series

Haime I have not seen. The absence of spinose costæ seems to be a character of more value for distinguishing true *Ulophyllia* than the position of the larger teeth. But the Red Sea species figured by Klunzinger look more distinct, on account of their acute, nearly naked collines, which thus approach those of *Tridacophyllia*. The American species that have been called *Ulophyllia* belong to *Isophyllia*.

In our Bermuda *Isophylliæ* similar variations in the position of the larger teeth often occur, as will be noted in the descriptions. Indeed, the larger teeth are more frequently the proximal ones.

It may eventually be necessary to reunite all these groups under the original genus *Mussa*, if a few additional intermediate forms should be discovered.

* This is due to the impossiblity of drawing by hand, with accuracy, the vast number of unequal septa and their numerous variable denticles. All the figures are, therefore, generalized or idealized by the artist, so that the septa and their teeth are much too regular and uniform, and for the same reason, they also appear too numerous and too crowded.

I can find no evidence of more than three species, and I am not certain that more than two of these can eventually be kept apart. Quelch, however, with a much smaller series, recorded (op. cit., pp. 10, 11) eight species from Bermuda, including the young forms that he called *Lithophyllia.* Probably all his Bermuda forms belong to *I. dipsacea* and *I. fragilis.*

When young, all species of this genus and of *Mussa* (including *Symphyllia*), etc., have a simple, more or less cup-shaped coral, attached by a rather broad base. These may become in some cases 25 to 40^{mm} in diameter before they begin to form marginal infoldings, as a commencement of the process of fission.

Such simple young forms have been put in a special genus (*Scolymia* Haime, 1852, or *Lithophyllia* Edw. and Haime, 1857). The type of this genus was *M. lacera* Pallas. It appears to be the young of *Mussa carduus* (Ellis and Sol., sp.).*

Therefore *Lithophyllia* is a synonym of *Mussa*, rather than of *Isophyllia*, though several species described by Duch. and Mich. unquestionably belong to *Isophyllia*, as indicated in the synonymy above. All the Bermuda simple forms are young of *Isophyllia*, and mostly of *I. dipsacea* and *I. fragilis.* Pl xix, fig. 5.

The generic relations of these simple young forms can usually be told by the character and spinulation of the costæ. In *Mussa* the costæ are generally imperfect, with rows of strong, sharp spines, often recurved. In *Isophyllia* the costæ are generally raised and continuous ribs, often lamelliform, and their spines are small and more regular, usually more like serrations of the edge. In *Mussa* the septa are also more strongly and more unevenly serrate or lacerate, especially toward the outer end.

At a later stage, but varying in size, even in the same species, the edge of the cup begins to be undulated or lobed; most commonly there are six outfoldings and six infoldings at first, corresponding to the primary and secondary septa, but the number may vary from three to seven, or even eight or more. When four lobes are formed the coral is apt to be squarish. (See pl. xvii, fig. 4.) These primary folds and lobes may continue to grow regularly for some time, till several large marginal calicles, usually five or six, develop around the central, stellate, primary calicle (pl. xvii, figs. 1–2). This is the most normal and regular mode of growth for all the species of this

* This large species should, therefore, be called *Mussa lacera* (Pallas) Oken The calicles are often 40 to 60^{mm} broad, mostly isolated, costæ strongly spinose It is found throughout the West Indies, to South America, but not at the Bermudas. See below, p. 180.

genus. The infolding of the margin is often delayed till the calicle is 25 to 40^{mm} across.

But frequently the first outfoldings of the margin begin much sooner than usual to form secondary folds of the same nature, before the first series of calicles is fully formed. This gives rise to the early formation of a much larger number of calicles, some of which may long remain incomplete and united in series. For the same reason the calicles in such a coral will be, for some time, smaller in size than those that divide more slowly, thus giving them a very different appearance. But both conditions may exist at the same time on some specimens, and many irregularities constantly occur. (See pl. xvii, figs. 5, 6.) Some species, however, normally divide more rapidly than others. (Pl. xx, fig. 1.) The outfoldings of the margin may not much affect its regular circular outline, as in pl. xvii, figs. 1, 2, (*I. fragilis*). But in other cases they may be so extensive as to produce a deeply lobulated outline, when seen from below, as in pl. xvii, fig. 3, (*I. fragilis*). Large specimens of either species (see pl. xvii, figs. 5, 6 of *fragilis*) generally have a large number of calicles, irregularly arranged, many of them isolated, but mostly in short series.

Resorption of parts of the walls and septa or of the entire thickness of the collines frequently takes place, and thus alters the appearance. In some cases this results in breaking up the collines into detached portions or isolated columns. This I have seen in *I. fragilis*.

The genus is chiefly, or perhaps entirely, American. The simple form described as *I. australis*, first from Australia, was considered the type of a special genus, *Homophyllia*, by Bruggmann, 1877. The species described by Klunzinger from the Red Sea as *I. erythræa* appears to me to belong rather to *Ulophyllia* or *Mussa*.

Isophyllia dipsacea Dana Rose Coral

Mussa dipsacea Dana, Zooph., p. 184, 1846.

Symphyllia dipsacea Edw. and Haime, Corall., ii, p. 378, 1857.

Isophyllia dipsacea Verrill, Bull. Mus. Comp. Zool., i, p. 49, 1864; Pourtalès, Deep Sea Corals, p. 71, 1871; Florida Reefs, pl. vii, figs. 1–8, 1880.

Isophyllia australis (*pars*) Edw. and Haime, Corall., ii, p. 375 (young), 1857.

? *Symphyllia anemone* + *S. comferta* + *S. aglæ* + *S. helianthus* + *S. Thomasiana* + *S. aspera* + *S. cylindrica* + *S. Knoxi* + *S. verrucosa* (abnormal) Duch. and Mich., Corall. Antill., pp. 71, 72, 1860.

? *Lithophyllia argemone* + *L. cylindrica* Duch. and Mich., op. cit., p. 68, pl. ix, fig. 121, pl. x, fig. 15, pl. ix, figs. 17, 18, 1860, (young).

Isophyllia australis + *cylindrica* + *Knoxi* + *Lithophyllia Cubensis* + *L. lacera* (*non* Pallas) + *L. argemone* Quelch, Voy. Chall., Zoöl., xvi, pp. 10, 11, 12, pp. 83–86, 1886.

PLATE XVIII. FIGURE 2. PLATE XIX. FIGURES 2, 3. PLATE XX. FIGURE 2

This species occurs in abundance at the Bermudas, in shallow water (1 to 20 feet) on nearly all the reefs, and also along the shores attached to rocks, and even to small stones on shell-sand bottoms, where other corals do not grow. It is very abundant even in Harrington Sound, where but few species of corals are found, owing to the less density of the water.

I have personally collected and studied hundreds of specimens of this and the following species, and have kept large numbers alive, to ascertain, if possible, whether two or more species occur there, and to learn the character and extent of the variations.

Probably no coral varies more than this in form, mode of growth, union and separation of the calicles, and consequently in the size and form of the calicles, character of the columella, number and size of the teeth of the septa, extent of the epitheca, etc.

Therefore many nominal species have been founded, especially by Duch. and Mich., on mere stages of growth and on ordinary individual variations in the mode of growth, union of the walls, etc.

The colors of the living animals of this and *fragilis* are also extremely variable, and often very beautiful Most commonly they are variegated with gray, lavender blue, green, and flake-white in variable proportions. But specimens often occurred, especially in 1898, rarely in 1901, that were largely or wholly bright emerald-green, or grass-green. I have had some that were bright green over one-half the surface, and lavender and gray on the other half. The difference in the external appearance of the animals of this and *fragilis* are slight Therefore the color of the animal cannot be used to distinguish species nor even varieties.

The same is true of the isolation and union of the calicles in series, for a single specimen often shows the extreme conditions on its different parts. The collines generally have simple, solid, rather thick walls, but sometimes they are double with a groove on the summit, as is the case more commonly in *fragilis*.

This species has a heavier and more solid coral than *fragilis*, with stronger and thicker walls. It can best be distinguished by the decidedly thicker and closer septa, which have stronger, stouter, and more regular, spiniform teeth on their edges, the size of the teeth decidedly increasing toward the columella, where the septa are also usually distinctly thicker.

The calicles, when well grown, are generally broader, more flaring, and more shallow. The costæ are less prominent, thicker,

closer, and strongly spinulose, with small, but strong, acute, rough spines. The collines are radial at first, but may soon become sinuous. They may be solid, or they may be double with a groove on top, more or less wide and deep. In many large specimens a considerable proportion of the calicles are simple.

A medium specimen, 80^{mm} across, has usually 10 to 12 septa to the centimeter, of which 7 or 8 are larger ones, the others being much smaller. The larger calicles are 20 to 25^{mm} wide, but others on the same coral are not over 15^{mm}; they are 8 to 10^{mm} deep. This example has double walls. The columella in this is made up of few strong trabeculæ and angular spines. In this specimen the larger septa are thickened toward the columella and bear on that part large, thick, spiniform teeth; more distally the teeth are smaller, decreasing to the margin. Pl. xviii, fig. 2.

A very well grown Bermudian specimen, 100^{mm} in diameter, has five pretty nearly circumscribed large marginal calicles; four of them are just beginning to have marginal infoldings, for new collines. In this the diameter of the undivided calicles is 28^{mm}, but some that are beginning to divide are 30 to 33^{mm} across, transversely, but 40 to 45^{mm} across the broadest parts; depth 10 to 13^{mm}. The collines are double-walled in most places, with a wide, deep, intermural groove.

The septa are numerous, close, rather thick, especially toward the columella; the edges are strongly and rather regularly toothed, the teeth being mostly acute and thickened, generally decreasing in length toward the margin of the calicles. The costæ are thickened, little elevated, roughly spinose, with small acute spines.

This coral was attached by a small central pedicel and the under side is six-lobed and imperfectly covered with epitheca to within 4 to 8^{mm} of the margin. The columella is formed of rather slender, loose trabecular and spinous processes. Pl. xix, fig. 2.

A Bermudian specimen with six unusually large and open, nearly simple, marginal calicles has six large, regular marginal lobes, conspicuous on the under side; only one of these has begun to infold the margin, for secondary divisions. The collines are thick and nearly solid. The five undivided marginal calicles are 22, 23, 28, 32, and 35^{mm}, in transverse internal diameter, from wall to wall; the one that has just begun to divide is 40^{mm} across and 52^{mm} long; the most regular one is 32^{mm} wide and 40^{mm} long; the central calicle is about 20 by 25^{mm} across, and 15^{mm} deep; the marginal calicles are about 8 to 10^{mm} deep. (Pl. xx, fig. 2.)

The septa are strong, thickest toward the columella, where they bear large, stout, angular, acute teeth, often irregular and united by their bases. Small thin septa usually alternate with the larger ones, and have long, thin, sharp teeth. There are usually about five larger and four smaller septa to a centimeter. The columella is small and composed of many slender processes in some of the calicles, and of fewer, stouter ones in others. The costæ are thick, not much elevated, roughly spinulose, with small acute spines.

This specimen is quite different from most, in appearance, owing to the great size, shallowness, and regularity of its calicles, but it seems to be simply a specimen that has delayed its secondary divisions longer than usual, so that its calicles have grown broader.

A few examples of this species have very shallow calicles, the inner surface of the cup being nearly flat, but in other respects they agree with the ordinary forms.

Two or more specimens, crowded when young, may graft themselves together and later form a solid coral similar to the normal ones, but usually somewhat more irregular.

Abnormal specimens, owing to injuries or disease, may have the septa very much thickened and often hollow, and their spines may be hollow, swollen, or even bulbous at the tips. *S. verrucosa* D. and M. was evidently based on a specimen of this kind.

Our largest perfect specimens are 150 to 200^{mm} (six to eight inches) in diameter, but larger and less perfect ones were often seen, perhaps the largest were 10 inches across.

This species is found from Bermuda and the Florida Reefs, southward, throughout all the West Indies.

Isophyllia fragilis (Dana) Ver. Rose Coral. Lettuce Coral.

Mussa fragilis Dana, Zooph. Expl. Exp , p. 185, pl. viii, fig. 9, 1846.

Isophyllia fragilis Verrill, in Dana, Coral Islands, ed. 2, p. 380, 1874, ed 3, p. 424, 1890. Quelch, Voy. Chall., Zoöl., xvi, p. 84.

Symphyllia Guadulpensis Edw. and Haime, Ann. Sci. Nat., xi, p. 256, 1849; Hist. Corall., ii, p. 378, 1857. (Young.)

Isophyllia Guadulpensis Pourtalès, Deep Sea Corals, p. 71, 1871.

Symphyllia ? strigosa + ? S. anemone + ? S. marginata Duch. and Mich., Corall Antill., pp. 70, 72, pl. x, fig. 16, 1860. (Indeterminable from the descriptions.)

Plate XVI. Figures 1, 2. Plate XVII. Figures 1-7.
Plate XVIII. Figure 1 Plate XIX. Figures 1, 4, 5

This species, which is about as common as *dipsacea* at Bermuda, and lives with it, can best be distinguished from the latter by the thin, lacerate-toothed, very unequal principal septa, which are not

crowded, but have rather wide interseptal spaces, in which are the much thinner and narrower small septa; by the usually deep, steep-walled calicles; and by the prominent, thin, lamelliform, rather distant, and only slightly serrulate external costæ.

4

4a

Figure 4.—*Isophyllia fragilis* (D.). Portion of a specimen having many of the calicles isolated, with the polyps partly contracted Photographed from nature. About ⅘ natural size.

Figure 4a.—The same, with the polyps. A specimen having two calicles isolated and the rest in a long connected series. About ⅘ natural size.

The collines may be high, steep, and narrow, with a thin solid wall, or they may be double-walled, with a groove on top; or they may be entirely disunited in some specimens, up to 2·5 inches (65^{mm}) in diameter. But these variations in the collines may occur on a single specimen. The septa are decidedly thinner, fewer, and much more openly arranged than in *dipsacea* of the same size, and the latter has shorter, much stouter, and more regular septal teeth, and less prominent, closer, thicker, and more spinulose costæ.

The original type* of Dana belongs to the Museum of Yale

* Vaughan (op. cit., pp. 41, 42, 1901) erroneously refers this species to *Colpophyllia gyrosa*. He says that from the descriptions "no specific distinction between the two can be discovered." This statement seems absurd, for the *Mussa fragilis*=*Isophyllia* was very well described and figured by Dana He also described and figured the strong, spiniform teeth of the septa. Such a mistake seems unaccountable, and the more so because Quelch had already referred it to *Isophyllia*, in addition to my previous determination of it. The type of *I. fragilis*, in the Yale Museum, I have now figured. (See pl. xvi, fig. 1)

University. It is attached to a stone on which the name and locality (Bermuda) were written in Dana's handwriting. The stone is of granitoid character, but it may have been taken to Bermuda in ballast, as often happens there. It belonged to the Redfield Bermuda collection, which was presented to Yale University many years ago. No. 4298.

This specimen, owing to its growing upon an angular corner of a stone, is quite irregular in form; one side is closely adherent to the stone, almost to the edge, while the other side is free from 10 to 35^{mm}, and shows very well the thin lamellate costæ, finely, unevenly serrulate, especially distally where they are highest. They are about one-third as thick as the width of the intercostal spaces. The collines are irregular and crooked; most of them are double-walled, with a slight groove on top, the walls themselves being thin; in some places the walls are simple, or nearly so. The valleys are unequal; most are elongated, deep, and narrowed by crowding; others are nearly circular and less deep; the longer ones are 14 to 20^{mm} wide, from wall to wall; the larger circular ones are about 24^{mm} broad (in other specimens they are often 30^{mm} broad).

The septa are very thin, very unequal, openly arranged; their edges are irregularly and sharply dentate, with long, thin, flat, acute or lacerate teeth, unequal in length and breadth, rough on their sides and ends; the larger teeth are near the columella There are about six principal septa to a centimeter, with four or five much thinner ones. The columella is open and loose in structure, composed of slender, irregular, rough spiniform processes from the septa. This coral is 80^{mm} broad and 49^{mm} high, where thickest (pl. xvi, fig. 1).

A somewhat younger, turbinate specimen from Bermuda (coll. 1901), agreeing very closely with the type in the characters of the septa, dentations, costæ, etc., has deeper and more flaring calicles of somewhat large size, 20 to 30^{mm} in diameter. In this the walls are in nearly all cases separate; they have united partially in some of the collines, leaving a wide furrow, but in two collines they form only a very thin and simple wall, showing that this is a matter of small importance. This specimen was attached by a small pedicel, leaving the lobulated outer wall free for 30 to 35^{mm} all around; the costæ are thin, high, laminar, and very finely serrulate. (Pl. xix, fig. 1.)

Other regular young specimens, when attached by a small pedicel, have an imperfect epitheca that covers most of the under side, except within 4 or 5^{mm} from the edge, and the base may be flat and horizontal, circular or lobed. (Pl. xvii, figs. 1–3.)

Simple young specimens, 20 to 25^{mm} in diameter, are low, shallow, nearly circular, and usually show no trace of division or lobulation of the margins. They may have five cycles of septa, with the larger ones lacerately toothed as in the adult. Plate xix, fig. 5.

The radial lobes and collines vary greatly with age; the most regular young ones, 40 to 65^{mm} across, usually have six regular, radial calicinal lobes, with six radial collines, and a central primary calicle, but the primary lobes are often five, more rarely four or three. The collines are frequently solid or nearly so, without a groove on top. (Pl. xvii, figures 1–3.)

In ordinary adult specimens the septa are thin, generally rather broad, unequal, and not very close together. The number to a centimeter may be eight to twelve, in fully formed calicles, but in imperfectly formed calicles there may be ten to twelve or more. The larger ones are normally thin, but firm, broadly rounded toward the margin, and not very prominent above the wall. But the form varies greatly in different calicles. The serrations are generally numerous, unequal, and mostly rather long, the larger teeth being flat, not very wide at base, and with the tips mostly acute, but sometimes forked or lacerate. Those toward the outer ends of the septa are usually decidedly shorter than the inner ones, but they are irregularly larger and smaller on the whole edge. The columella may be rather large and spongy, or it may be small and trabecular or laminose even on the same specimen

The costæ are well developed, and like raised, thin ribs, separated by regular grooves, and with the edges sharply and rather regularly serrate, with the teeth very much smaller than those of the septa. Sometimes the costæ are sublamellar. They may be confined to a narrow zone close to the edge, or they may be more than 25^{mm} long, according to the variable extent of the epitheca.

This species is more apt to have part of the corallites isolated and nearly circular than *I. dipsacea.* Frequently many of them are disunited for much of their length. The larger round calicles may sometimes become 40^{mm} in diameter before they begin to divide.

One of our Bermudian specimens has, on one side, a simple, curved, linear valley, five inches long (125^{mm}), containing a row of uniform, united calicles, while on the other side the calicles are partly isolated, and partly in short groups of two or three, and of various forms.

In the form and colors of the soft parts this species does not differ materially from the last. Its colors are equally variable, but per-

haps the bright green colors are more common in this species. The tentacles are less numerous.

When full grown this species is often 6 to 8 inches (150 to 200^{mm}) in diameter and 4 to 5 inches thick.

When the calicles are crowded resorption of portions of the collines may break them up into detached cone-like or columnar portions, or may simply cause interruptions of their continuity.

Specimens partially killed by injury to the calicles may repair themselves by budding out new cup-shaped calicles from the mutilated parts, and then the new growth may go on just as in the case of young ones arising from eggs.

During the spring of 1901, owing to a period of unusually cold and stormy weather in February and March, many dead or partly dead specimens of this species and *I. dipsacea* were seen, in place, and even those that seemed to be uninjured refused to expand, though in previous years they expanded very freely in confinement. They expand best in bright sunshine and during hot days.

This species is common at the Bermudas, in shallow water. Florida Reefs. West Indies to St. Thomas. Probably generally distributed in the West Indies.

In most collections this species is confused with *I. dipsacea*, usually under the latter name. It is not always easy to distinguish the two, without careful examination. It is possible that the two forms may eventually have to be united as varieties of one species. But all the numerous specimens of this group that I have hitherto studied can be pretty definitely arranged under the two species, by the differences in the septa and costæ.

The following species seems to be so different that it can hardly be confused with either of the preceding, unless when young.

Isophyllia multiflora V., sp. nov.

? *Isophyllia multilamella* Pourt., Deep Sea Corals, p. 70, 1871 (*non* Duch. and Mich.)

PLATE XX. FIGURE 1. PLATE XXV. FIGURE 1.

This species is remarkable for the rapid division of the calicles, and the unusually small size of the calicles, which are very crowded, and many of them are isolated or in very short series.

The collines are mostly irregular, simple, narrow, with a thin solid wall, but in the larger examples they are often meandriniform The calicles are rather deep, mostly decidedly stellate, generally 14 or 15^{mm} in diameter, but varying from 12 to 18^{mm}; depth 6 to 8^{mm}.

Septa rather narrow and thin, closely arranged, their edges covered with numerous rather slender, acute, rough teeth, the proximal ones usually the larger. The sides of the septa and teeth are covered with numerous, sharp, rough, conical grains, giving them a rough or hispid appearance, under a lens. The columella is well developed, rough, porous, composed of small, irregular, contorted and hispid lamellæ and spinous processes of the septa. There are usually 11 or 12 well-formed septa to a centimeter, besides some rudimentary ones. The costæ are not much elevated, except close to the edge, slightly thickened, hispid laterally, and sharply serrate with small rough spinules. The epitheca is imperfect, but usually covers much of the lower side.

The animals of this coral are smaller than in the other species, and they form elegant crowded groups, when expanded. The colors are similar to those of *dipsacea* and *fragilis*, but emerald-green is perhaps a more common color in this.

Our largest Bermudian specimen (pl. xx, fig. 1) is 40^{mm} thick and 85^{mm} across, with a nearly flat upper surface. This has 27 distinct calicinal centers, of which only five or six are isolated, most of the others forming series of two or three. The margin has about twelve small lobes.

A very regular small specimen (pl. xxi, fig. 1) is about 55^{mm} broad and 25^{mm} high, with twelve small marginal lobes and twelve radial collines, six of which are primary and extend to the central calicle in sinuous lines, mostly uniting to the five-lobed colline surrounding the central calicle, while the short secondary collines are nearly radial and unequally developed. Each of the six primary marginal calicles has already divided into three, more or less separated calicles, and the secondary central calicle has formed four smaller ones around itself, so that it is 5-lobed. Thus there are now 23 distinct calicinal centers on this small specimen. No. 4000.

A considerably larger one of *I. dipsacea* or *I. fragilis* would usually have but seven calicles. This rapid increase in the calicles seems to be characteristic of this species, which often resembles an astræan coral, such as *Acanthastræa*, in the size and shape of its calicles and septal teeth, though many of the calicles are not isolated, like those of the latter.

I am unable to refer this rather rare species to any of those described by Duch. and Mich., or others,* unless it be the form

* The *Isophyllia Danaana* (Edw. and H., as *Mycetophyllia*, Hist., ii, p. 377, pl. D4, fig. 2) resembles this species in the width of the calicles and valleys, and in its septa, but the valleys are long and sinuous, the collines low and obtuse; and the columella is feebly developed.

briefly described by Pourtalès as *multilamella*, which seems quite distinct from the species to which he doubtfully referred it.

Bermuda and the Florida Reefs. Occurs also in the West Indies, at the Bahamas, etc. It occurred on the Serpuline Atolls, near Hungry Bay, and in Great Sound, Bermuda.

Mussa (Symphyllia) hispida V., sp. nov.

Astræa dipsacea Dana, Zoöph., p. 225, pl. xi, figs. 4–4*d*, 1846 (*non* Lam.)
Acanthastræa dipsacea Verrill, in Dana, Coral Islands, ed 1, p. 380 ; ed 3, p 421, 1890, *non* E. & H.

PLATE XXI. FIGURES 2, 2*a*, 2*b*, 2*c*.

Dana's type of this species is preserved in the Museum of Yale University in good condition. No. 4287.

It is an astreiform, hemispherical mass, about 100^{mm} in diameter. The calicles are mostly simple and clearly circumscribed ; some are circular, but many are elliptical or irregular ; some are elongated and have 2, 3, or 4 centers in a series, as in *I. multiflora*.

The walls between the calicles are double and separated by an openly vesicular exothecal structure, the proper wall being thin and solid. The septa are thin, sharply granulated laterally, deeply laciniate, especially near the columella, and have long, rough, lacerate and hispid teeth, largest toward the top. The columella is large, loosely and coarsely trabecular, with rough spines on the surface. In a section the coral appears very cellular ; the endothecal dissepiments are compound, long, and much inclined ; septa are perforate and trabecular.

Diameter of calicles, 8 to 18^{mm} ; the elongated calicles with two or three centers may be 25 to 30^{mm} long ; 10 to 12^{mm} wide ; depth $7–10^{mm}$; distance between them, 2 to 4^{mm}. West Indies (t. Dana). Rare in collections.

This species resembles *Acanthastræa*, in which I formerly placed it, but it has the structure of a *Mussa*. The double wall and vesicular exotheca are not found in *Acanthastræa*, nor the elongated calicles with several centers, dividing by fission.

The locality of Dana's type was uncertain, but was supposed to be West Indian. A similar species is found at Pernambuco, Brazil. See below; List of Brazilian Corals, and pl. xxi, f. 3.

Mussa (Symphyllia) rigida (Dana) Ver.

Astræa (*Fissicella*) *rigida* Dana, Zoöph., p. 287, pl. xii, figs. 8*a*–8*d*, 1846.
Prionastræa ? rigida Edw. and Haime, Hist. Corall., ii, p. 528, 1857.
Isophyllia rigida Verrill, Bull. Mus. Comp. Zoöl , i, p. 50, 1864 ; Coral Islands, ed. 3, p. 422 (*non* Pourtalès).

PLATE XXV. FIGURES 2, 3.

The *Isophyllia rigida* Verrill (Bull. Mus. Comp. Zoöl., i, p. 50, 1864) was based on *Astrea rigida* Dana (Zoöph., p. 237, 1846). The type of the latter is in the Museum of Yale University. It is a badly beach-worn, astreiform specimen, with irregular polygonal calicles, mostly 10 to 12^{mm} across. The walls are very solid, often 3 to 4^{mm} thick. The edges of the septa are entirely destroyed. In sections it resembles an *Isophyllia* with unusually well isolated calicles. Its origin is unknown; West Indies? No. 4297.

Several fresh specimens from the Bahamas (coll. R. P. Whitfield), Amer. Mus. and Yale Mus, are apparently of this species. These have deep, roundish or irregular, isolated calicles, $10–15^{mm}$ in diameter; many are dividing; septa about 30, stout, exsert, strongly spinose-dentate, the distal teeth larger, divergent; upper ones erect, prominent, acute; columella small, trabecular. Walls entirely united, nearly solid. The larger hemispherical masses are $90–100^{mm}$ across. No. 6616. Plate xxxiii, fig. 4.

Allied to *M. Harttii*, var. *conferta*, but septa are thicker, with the distal erect teeth much stronger; walls more solid.

Mussa Harttii Verrill.

Mussa Harttii + *Symphyllia Harttii* Verrill, these Trans., i, pp 357, 358, 1868. R. Rathbun, Proc Boston Soc Nat Hist., ii, p. 40, 1878; Amer Naturalist, xiii, p 542, 1879.

PLATE XXII. FIGURES 1–2. PLATE XXIII. FIGURES 1, 2.
PLATE XXV. FIGURE 4. PLATE XXXIII. FIGURE 8

A larger series of this species than that first studied has convinced me that both the forms originally described by me, provisionally, as distinct, are really only extreme growth-forms of one variable species. In the Museum of Yale University there are several intermediate specimens, some of which I have now figured. (Pl. xxii, figs. 1, 2.) It occurs with all the corallites united to their summits by a vesicular exotheca (*Symphyllia*-form, pl. xxiii, fig. 1), var. *conferta;* in dichotomous groups with the calicles and branches disunited, and without exotheca (fig. 2), var. *laxa;* in masses with the corallites free for only a short distance, leaving only deep grooves between (pl. xxii, fig. 1); in groups in which the corallites are free for ½ or ⅛ their lengths, with exotheca below (fig. 2), var. *intermedia;* and in various other intermediate forms.

One specimen (pl. xxxiii, fig. 3) consists of a cluster of seven calicles of the *Symphyllia*-form, arising from a dichotomous branch of the typical *Mussa*-form. No. 4545.

The calicles generally separate rather quickly in all the forms, and a large part of them are circular and irregularly elliptical, or hour-glass shape, owing to imperfect division. The size of the calicles, even when circular, is quite variable, but is mostly between 12 and 18^{mm}; the elliptical ones are often 25 to 30^{mm} long.

The septa are generally very thin, deeply lacerately toothed, the longer teeth being on the wider and rounded upper portion. They are usually rather openly spaced, about 9 or 10 wide ones to a centimeter, with as many very narrow or rudimentary alternating ones. In some specimens there are 12 large septa to a centimeter.

In the extreme form, var. *confertifolia* (fig. xxii, fig. 1), there are 16 larger and 16 smaller, very thin septa to a centimeter.

The columella is generally well developed, very porous, composed of numerous rough, irregular trabecular processes, with free spines on its surface. But sometimes it is coarsely, rudely trabecular and very loosely arranged, or it may be almost lacking.

The costæ are usually rather thin and not much elevated, but they are covered with numerous, rather close, sharp, elongated, often recurved spinules. These costal spines are very characteristic for this species, but in some specimens they become fewer, more irregular and less elongated, on some parts at least.

Brazil, from Pernambuco to Abrolhos Reefs; Victoria; Porto Seguro, Bahia, Mar Grande, etc., common,—C. F. Hartt; R. Rathbun. According to Mr. Rathbun the clusters are sometimes 2 feet across.

Var. *confertifolia* Ver., nov.

PLATE XXII. FIGURE 1

The type of this variety is much more delicate than usual, with much more numerous, thinner, and crowded septa (about 16 larger and 16 smaller septa to the centimeter); they are covered with long, slender, sharp teeth. The columella is well developed and finely trabecular. The costæ are small, close, and crowdedly spinose, with small acute spinules, much as in the typical form, but smaller

The corallites are short, pretty closely crowded, circular, elliptical, and some are irregular and rather smaller than usual. They are united for only a short distance, or not at all, by exotheca.

Pernambuco, Brazil,—Derby and Wilmot, 1870. No. 4551.

Mussa lacera (Pallas) Oken.

Madrepora lacera Pallas, Elench. Zooph., p. 298, 1766. Esper, Pflanz., i, p. 148, pl. xxv, fig. 2, 1791.
Madrepora carduus Ellis and Sol., Zooph., p. 153, pl. xxv, 1786.
Mussa lacera Oken, Lehr. Naturg., p. 75, 1815.
Caryophyllia carduus Lam., Hist. Anim. sans Vert., ii, p. 229, 1816; ed. 2, p. 357.
Caryophyllia lacera (*pars*) Ehr., Corall. R. Meeres, p. 92, 1834. Edw. and Haime, Ann. Sci. Nat., ii, p. 238, 1849.
Mussa carduus Dana, Zooph. Expl. Exp., p. 175, 1846. Edw. and Haime, Hist. Corall., ii, p. 334, 1857.
Lithophyllia lacera Edw. and Haime, Hist. Corall., ii, p 291, 1857 (Young) + *L. Cubensis*, op. cit., p. 292.
Scolymia lacera Haime, Mem. Soc. Geol. France, iv, p 279, 1852. Bruggmann, Ann. and Mag. Nat. Hist., xx, p. 303, 1877. Vaughan, op. cit., pp. 6, 34, 1901.

This large species is common in the Bahamas and southward to Curacao.

On the Florida reefs it seems to be rather rare. It has not been found at the Bermudas. It forms dichotomous clumps, often more than a foot high and broad. The calicles, when full grown, are mostly isolated and nearly circular. They are from 40 to 65^{mm} in diameter, and sometimes more, but mostly about 50^{mm}. The calicles vary in depth, some being shallow, others rather deep. The septa are numerous and strongly toothed, but the teeth vary widely in form; usually the distal ones are much the larger. The larger septa are usually pretty thick, but sometimes they are thin and fragile. The exterior is covered with rows of strong, acute costal spines.

I regard the simple forms with broad calicles and wide base, referred by Edw. and Haime to *Lithophyllia lacera*, as the young of this species before fission takes place. The two forms occur in the same localities. It is certain that all the species of *Mussa* and *Isophyllia* have such a simple young stage, before they begin to divide, in which the diameter of the cup equals or exceeds that of the adult calicles after division. The size of the calicles and the number and character of the septa and their denticulations all correspond well in the two forms. Moreover, I have seen specimens of the simple *Lithopyllia*-form in which infoldings of the margin had already taken place, to begin the process of fission.

If this form be not the young of "*carduus*," as I believe, then its young have not been discovered, which would be remarkable in the case of such a large and common species.

Pallas described both forms and considered them the same, under the name of *M. lacera*. The type of *carduus* is still in the Hunterian Mus. (t. Young).

Probably the *Lithophyllia Cubensis* Edw. and Haime is only a slight variation of the same young form, for similar variations occur in the adult calicles.

Mussa angulosa (Pallas) Oken.

Madrepora angulosa Pallas, op. cit., p. 299, 1766. Esper, op. cit., i, p. 92, pl. vii, 1791.

Mussa angulosa Oken, Lehr. Naturg., p. 73, 1815. Dana, Zooph., p. 176, 1846. Edw. and Haime, Hist. Corall., ii, p. 329, 1857.

This species is closely allied to *M. lacera*. It differs from it in the smaller size of the branches and calicles, which are usually from 25 to 50^{mm} in diameter, and are apt to be crowded and angular. The principal septa are generally rather wide and exsert. A study of a large series of specimens might, perhaps, compel us to unite them in one species.

It is much less common in collection than *M. lacera*, and most specimens are beach-worn. It ranges from Florida to the Antilles, but seems to be rare on the Florida reefs.

Ulophyllia crispa (Lam.) Edw. and Haime.

Oulophyllia crispa Edw. and H., Ann. Sci. Nat., ser. 3, xi, p. 268, 1849.

Ulophyllia crispa Edw. and H., Hist. Corall., ii, p. 378, 1857.

I have studied a fine large specimen from Singapore, in the Ward collection, now in the Field Columbian Museum, at Chicago.

This is 12×8 inches across, and about 6 inches thick. The valleys are mostly 15 to 20^{mm} wide, but some are 25 to 30^{mm} across in the widest places; depth 10 to 15^{mm}.

The septa are rather loosely arranged, usually 9 or 10 to a centimeter, mostly wide and strongly toothed at base, projecting but little above the walls, and not much thickened; narrow ones alternate in some places between the wider ones, but not regularly. The large teeth of the wide septa are mostly broad at base, triangular, about as broad as high, subequal; usually the larger ones are on the basal part, but not infrequently the larger ones are above the middle. The ridges or collines are angular, broad at base, thin and simple at the summit. Columella variable, sometimes well developed, trabecular, sometimes open or rudimentary. Exterior of the coral lobulated at the margin, faintly costulate, nearly smooth, and without spines.

This is not a West Indian species, as some writers have supposed. All specimens that I have seen were from Singapore.

Several other, apparently distinct species, have been described from the Indo-Pacific region. Among them are the following :—

U. aspera Quelch, op. cit., xvi, p. 88, pl. iii, figs 5–5*b*. Banda.

U. cellulosa Quelch, op. cit., p. 87, pl. iii, figs. 6–6*c*, 1886. Banda.

U. maxima Rehberg, Abh. Geb. Naturw. Ver., Hamburg, xii, p 18, pl. i, fig. 12, 1892. Duke of York Island.

U. Stuhlmanni Rehb., op. cit., p. 17. Zanzibar.

Addenda to Favitinæ.

The following species should have been inserted on page 91.

Favia Whitfieldi Ver , sp nov

PLATE XXV FIGURE 5

This coral forms rounded masses, up to four inches (100^{mm}) in diameter. Calicles a little elevated, rather large, $8–12^{mm}$ in diameter, mostly nearly circular ; some are elliptical and undergoing fission; a few are irregularly lobed. Their cavities are rather deep, funnel-shaped, narrow at the bottom.

Septa somewhat exsert, rounded at the summit, and roughly serrate ; paliform lobe well developed, serrate. Columella small, lamellose or trabecular ; walls thick, solid, separated by dense exotheca having few cellules in one row.

Nassau, N. P.,—coll. R. P. Whitfield. Two good, fresh specimens are in the American Museum Nat. Hist., New York. No. 543. I have seen other specimens that are beach-worn.

This species is quite unlike any of the other West Indian species of *Favia*. Its general appearance, and especially its large, round calicles cause it to resemble some of the East Indian species. Its septa are more roughly serrate than in most species.

Family **Echinoporidæ**. Emended.

Coral usually foliaceous or frondose, sometimes branched, rarely encrusting, generally thin, with the exotheca or cœnenchyma sparingly developed and usually cellular, but sometimes solid (*Acanthopora*). Corallites short, often obliquely appressed ; increasing chiefly by marginal, basal, or intercostal budding, generally scattered irregularly and only on one side of the foliaceous species, but sometimes on both sides, and not forming collines, but sometimes arranged in short rows.

Septa often strongly exsert, dentate or lacerate, the distal ones usually continuous with the costæ. Common base often thin, but firm, imperforate, irregularly costate, often echinulate.

These corals often resemble fungian corals, like *Agaricia* and *Podabacia*, but they have distinct and often large exothecal dissepiments and lack synapticulæ.

To this family I now unite the genus *Mycedium* Oken, as emended, = *Phyllastræa* Dana.

Mycedium (Oken) Edw. and Haime. Type *M. elephantotus* (Pallas; Esper)

Mycedium (*pars*) Oken, Lehr. Naturg., i, 69, 1815.
Agaricia (*pars*) Ehr., Corall., p 105, 1834 (*non* Lam.)
Phyllastræa Dana, Zooph Expl Exped., p 269, 1846
Helioseris (*pars*) Edw. and Haime, Compt -rend., xxix, p. 72, 1849.
Mycedium (*pars*) Edw. and Haime, Ann. Sci. Nat., xv, p. 130, 1851; Hist Nat. Corall., iii, p. 72, 1860 (*non Mycedia* Dana, 1846).

The coral in this genus usually forms thin, foliaceous, often contorted fronds, simple or clustered. They may be unifacial or bifacial. The calicles are rather large, one-sided, oblique or appressed, stellate, usually scattered, not in long series. Collines rudimentary or lacking. Septa rather few, thickened, serrate or laciniate, exsert, prominent externally, continuous from calicle to calicle, as septocostæ. Costæ coarse, rough, serrate. Under side of coral rather coarsely costate.

Much unnecessary confusion has arisen as to the characters of this genus.

This has been due chiefly to the fact that most writers have failed to recognize the true characters of the type species, *Madrepora elephantotus** of Pallas, and have had very different species under this name, including two or more West Indian species of *Agaricia*, as will be shown under that genus, which have nothing to do with the true *elephantotus*. Milne-Edw. and Haime had, however, a more correct idea of the nature of the original genus, and their interpretation of it must hold good, even though they included some species that may better be placed elsewhere. But their species described as *elephantotus* is not the species of Pallas.

*** It has been suggested by Quelch that this spelling was a typographical error for *elephantopus*, but the allusion is plainly to the resemblance of a broad foliaceous coral to an elephant's ear, not to the foot. Some of the early polynomial writers gave these foliaceous corals the vernacular name "Elephants Ears." See Voy. Chall., xvi, p. 116, foot note.**

The *M. elephantotus* of Pallas was not an *Agaricia*, and was from "Oceanus Indicus." It belongs to a strictly Indo-Pacific group of corals. It was carefully described by Pallas, who said that he had seen but a *single* specimen. So that there was here no confusion due to an original mixture of several species. Such confusion was due to the confounding of other very unlike species with it by subsequent writers, even down to the present year.

Vaughan (op. cit., pp. 63, 64, 67, 1901) identifies it with a West Indian species very close to "*M. fragile*," from which he thinks it may be distinct (p. 67), and he states that he has seen good specimens, but does not give the characters. Therefore we can only infer that he considers it a West Indian foliaceous *Agaricia.*

Gregory (op. cit., pp. 280, 281, 1895) unites it definitely with the species *A. fragilis*, without a mark of doubt.

But the species described by Pallas, as plainly stated by him, was a widely different coral. He stated that the stars (calicles) are scattered, nearly in quincunx ; that they are prominent and lacerate; that the exterior of the coral has rather remote, rough, longitudinal costæ ; and that it seems intermediate between *M. agaricites* and *M. lactuca.*

None of these characters apply to the *Agaricia fragilis* and its allies, nor to any true *Agaricia.* His description* clearly indicates a coral with large, well-defined, stellate, scattered calicles, having lacerate septa, continuous distally with the subparallel, radial, granulated costæ, and with a coarse, roughly costate exterior surface, instead of one with the fine and even striations characteristic of *Agaricia fragilis* and its allies.

Pallas does not state that the calicles are in series, nor does he mention transverse sulci or collines, though these characters are carefully described by him under *M. agaricites* on a previous page. Hence we must conclude that they did not exist in his species, especially as he also says that the stars are nearly in quincunx. This is also the case in Esper's *elephantotus.*

* The original Latin description (Elench. Zoöph., p. 290) is as follows :—

"Madrepora conglomerata subturbinata, intus lamellis granulosis parallelis stellisque lacero-prominulis sparsis.

Corallium format laminam tenuem, subturbinatam, undato-crispam, laciniosam, sessilem, extus longitudinaliter porcis remotiusculis striatam ; intus præditam *lamellis* longitudinalibus, subparallelis, obtusis atque granulosis, quæ passim interruptæ sunt *stellis* rariusculis, fere in quincunces sparsis, lacero prominulis ; harum lamellæ istæ longitudinales quasi radii sunt. Locus : Oceanus Indicus.

Est quasi medium inter *M. Lactucam* & *agaricitis* quasdam varietates."

In fact, the description calls for a coarsely costate and rough coral, having scattered, stellate calicles, without collines.

The genus *Phyllastræa* Dana, based on *P. tubifex* Dana, corresponds to it in many respects, and is evidently congeneric with it, as noted by Edw. and Haime. Several other allied species are known to me.

Unfortunately, Edw. and Haime described as *elephantotus* a very distinct species, with very fine, close, equal costal striæ on the under side, and this has helped to perpetuate the confusion.

Esper (Pflanz., I, pl. xviii, figs. 1–4) figured as *M. elephantotus* Pallas, from the East Indies, a foliaceous species, with thin, clustered, convoluted fronds, strongly radially costate and serrate, but not echinate, below. Calicles stellate, appressed, raised proximally, with coarse, serrate, angular septa. This may well be the real *elephantotus* Pallas. It corresponds to it better than does any other figure.

Dana (Zoöph., p. 339) referred to a specimen of this species that he had seen in Peale's Museum, Philadelphia. This museum was burned many years ago, but Dana's sketch of this specimen is in the collections of the Yale Museum, with other unpublished drawings of corals presented by him.

It is probably of Indo-Pacific origin.

Ehrenberg described in 1834 a different species under the name of *Agaricia? elephantotus*.* It had calicles six lines in diameter, which is much larger than those of Esper's species.

The *Mycedium Okeni* Edw. and Haime (Hist., iii, p. 75, pl. D12, figs. 1*a*, 1*b* (not 2)), also has large calicles, 10^{mm} in diameter, and is probably very close to *elephantotus*, if not the same. It has rough, dentate, angular septa and the calicles somewhat in series. There is evidently an error in the numbering of the figures on the plate Quelch (op. cit., p. 116) referred this species to *Phyllastræa* Dana.

As for *M. cucullata* Ellis and Sol., it seems to be a species of *Agaricia* that cannot yet be positively identified. I have seen no specimens like it, nor do any of the modern descriptions agree very well with it. It is certainly *not* the same as *elephantotus* of Pallas, though it may be the species wrongly called by that name in some modern books; possibly it is the *M. elephantotus* of Edw. and Haime, but the latter is not the *elephantotus* Pallas. Gregory puts it as a synonym of *his* erroneous *elephantotus-fragilis*. The *A. cucullata* Dana is probably *A. purpurea* Les., described below.

* Doubting its real identity with the Pallasian species, he gave it the provisional name of *megastoma*, as noted also by Dana. It is perhaps a *Trachyphyllia*. Edw. and Haime, ii, p. 381, consider it the young of *T. lactuca*.

Some of the species of *Podabacia* resemble the *M. elephantotus* rather closely in form. This is particularly the case with an apparently undescribed species.*

Mycedium explanatum Verrill.

Phyllastræa explanata Verrill, Bull. Mus. Comp Zool, I, p 53, 1864.

PLATE XXIX. FIGURES 1*a*, 1*b*, 1*c*.

Additional specimens of this species show considerable variations from the type.

The fronds may be 8–10^{mm} thick, but become very thin, about .05^{mm}, at the margin. The under side is covered with unequal, raised, rounded, dichotomous costæ, the larger ones separated by three to six smaller ones; they are not serrulate nor echinate. On the older parts of the upper side, the corallites are large, often crowded, sometimes erect, but usually much inclined, mostly 8–10^{mm} in diameter. The septa vary from less than 12 to 18. Most commonly there are about 12 larger, subequal, very thick and prominent ones, with several much thinner ones of the 3d cycle. The large ones are perpendicular within, acute-angular at the summit, and con-

* *Podabacia dispar*, sp nov. Coral thin, foliaceous, in broad fronds, often concave above, and very thin at the edges. Common wall thin but compact, with few or no perforations, and covered with unequal, slightly raised, but continuous, costæ; often every 4th or 8th one is larger than the intermediate ones, which decrease in size according to the cycle of the septa with which they correspond, the smallest extending only a short distance from the edges. Their edges are finely granulated, and sometimes the larger ones are sparingly denticulate with very small, rough, irregular teeth, very much smaller than those of *P. crustacea*. The calicles are irregularly scattered; the larger ones are stellate, with a well developed columella, made up of irregular rough processes, sometimes united into a nearly solid mass. Septa thin, in three cycles, with some very thin perforated ones of the 4th cycle on the distal side. Usually there are nine to twelve larger septa; but in the outer calicles there are usually but six. The principal septa are wide, rise abruptly, and form a prominent, somewhat thickened lobe or angle at the summit, beyond which the edge is concave, thin, finely and sharply serrate, and continuous with the long septo-costæ. The prominent angle is often lacerate-toothed, but more frequently it is subentire. The septo-costæ are of several sizes, but generally the alternate ones are very thin, deeply lacerate, and much perforated close to the edge. The synapticulæ are large and conspicuous. Plate xxix, figs. 5, 5*a*

Diameter of the larger calicles, 4–6^{mm}; thickness of coral, 1.5 to 2 inches from edge, 6–8^{mm}.

Samoa Is. (Coll. H. A. Ward). Museum of Yale Univ., No. 6178, and Field Columb. Mus., Chicago.

vexly rounded externally, where they pass into thick, stout costæ, bearing several conical, rough, often hollow spines.

The summit is roughly serrate or spinulose; the inner edge and sides sharply and roughly granulated. The septo-costæ are often long, becoming thinner between the corallites than on their walls, and alternately thicker and thinner; they bear rather fine, strong, suberect, acute or lacerate spines. Toward the margin of the coral the corallites are smaller, more appressed, but circular, and have 6 to 12 larger, thick, prominent, exsert, acute, lacerate or spinose septa. The septo-costæ here become thinner and higher, with erect, rough or lacerate, rather distant spines. The columella is generally pretty well developed and roughly trabecular.

In sections (fig. 1*c*) the exotheca is pretty compact, with numerous rather small dissepiments, much smaller than in the next species.

Tahiti; Mus. Comp. Zoöl.; Yale Mus.; Field Columb. Mus.

For the older, thick form, with stout, swollen or rounded corallites, I have used the variety name, *turgida*. It often looks like a distinct species, but it grades into the thinner form. The differences are probably due to age.

Mycedium tenuicostatum Ver., sp. nov.

PLATE XXIX. FIGURES 2, 2*a*, 2*b*, 2*c*.

Coral forms a large foliaceous frond, more or less bent and irregular, considerably thickened and cellular in the older parts, but thin at the margin.

Exterior dichotomously costate; the costæ are unequal, 1 to 3 or 5 smaller ones between the larger; all are broadly rounded, more than twice as wide as the narrow intervening grooves; their surfaces are slightly rough with minute granules.

Corallites, toward the center of the upper side, are large and much crowded, expanded, prominent, often erect; the larger ones are 15 to 18^{mm} across, with very exsert, excurved, very roughly lacerate and spinose septa, which are thick and broad at the summit, with the inner edge flaring and roughly dentate and the outer or costal portion lacerately dentate. There are often 24 septa, in three cycles, but frequently only 12 to 18 are present; those of the third cycle are thin and narrow; sometimes smaller septa of the fourth cycle appear. Many corallites are but little prominent, with the septa thinner and not much exsert, angular at the summit, and roughly

spinulose. The septo-costæ are very thin and high, separated by spaces 4 to 6 times as wide, with few angular teeth.

In sections (fig. 2c), the exotheca is abundant, coarsely cellular; the dissepiments are convex and numerous. Singapore (?); Mus. Yale Univ.; Field Columb. Museum.

Echinopora elegans Ver., sp. nov

PLATE XXIX. FIGURE 8

The coral forms broad, thin, contorted, foliaceous fronds, sometimes 20 inches (500^{mm}) broad and 10 inches high, while the average thickness of the foliæ may be 3 to 4^{mm}, becoming very thin and translucent toward the margins, but yet compact and strong. Under side has rather loosely scattered small calicles in some parts, but toward the margins they are absent and the surface is evenly and closely covered with very small, nearly equal costæ, roughened with minute granules.

The upper side is roughly echinulate, and bears larger and more prominent calicles, which are rather crowded in some parts, but irregularly arranged, and becoming more scattered toward the margins, where the intervals are often equal to three or four times their diameter.

The larger corallites are verruciform, 3 to 4^{mm} in diameter, with very roughly echinulate septa and costæ.

The septa, in the larger calicles, form three very unequal cycles. The six primaries are much exsert, a little thickened, hispid laterally, and with the edges finely lacerately toothed. Usually they consist of two or three deeply divided lobes, the outer one standing on the outer thecal margin; the next, just within the calicle, is a little wider; the third, usually smaller, may represent the paliform lobe or tooth. Those of the second cycle are smaller and thinner, but lobed in the same way. Those of the third cycle are very small and narrow, or often rudimentary.

The septo-costæ are numerous, even, and rather close, represented, in general, by rows of small, upright, echinulate or lacerate spinules of about equal size; toward the margins the costulæ become more elevated, with the edge echino-lacerate.

The columella is usually well developed, finely trabecular or spongy.

Samoa (coll. Ward); Mus. Yale University and Field Columbian Museum. No. 6180.

Echinopora concinna Ver , sp. nov.

PLATE XXIX FIGURE 4.

The coral forms large, thin, foliaceous, bent fronds, a foot or more across, becoming very thin but firm at the edges. Both surfaces bear similar calicles in the type.

The septo-costæ are fine, very regular, only slightly raised, and each bears a row of regularly spaced, not crowded, small, erect, rough spinules, which give a neat and very regularly spinulose character to the surface.

The calicles are small, low, verruciform, rather open, with deep and conspicuous interseptal loculi. The septa are in three cycles, the smallest very thin and narrow. The larger ones are wide, thickened at the walls, a little prominent, angular at the summit, and lacerately toothed.

The columella is well developed and finely trabecular or spongy.

Diameter of calicles about 4^{mm}; their height about 1 to 2^{mm}.

Pelew I.,—coll. Ward; Yale Museum and Field Colum. Mus., Chicago. This is allied to *E. striatula* Studer, (Monatsb. Kong. Akad. Wiss., Berlin, 1877, p. 614, pl. iii, figs. 10*a*, *b*,) from New Britain.

Family **Agaricidæ** Ver., 1867

Fungidæ (*pars*) Dana, Zooph., p 283, 1846.
Lophoserinæ (*pars*) Edw. and Haime, Compt -rend , xxix, p 71, 1849 Hist Corall., iii, p. 85, 1860.
Lophoseridæ Duncan, Revision, p. 146, + *Plesiofungidæ* (*pars*), p 183, 1884
Agaricidæ Verrill, these Trans., i, p 542, 1867.

Corals generally compound, increasing mostly by marginal budding, often thin foliaceous or frondose, either unifacial or bifacial, sometimes in thick plates or massive. Calicles small and shallow, often without definite solid walls. Septa usually numerous, low, finely serrulate or subentire, more or less of them continuous, as septo-costæ, with those of adjacent calicles.

Synapticulæ exist between the septa, and in thick or massive forms there are also dissepiments. Outer wall compact, imperforate, usually with slender, serrulate costal striations, seldom echinate.

Polyps short, scarcely exsert, with small, short, verruciform, blunt or clavate, or often rudimentary tentacles.

Agaricia Lam. (emended). Type *A. undata* Ellis and Sol *

Agaricia (*pars*) Lamarck, Syst Anim. sans Vert., p. 375, 1801 (1st species is "*M. cucullata* Ellis and Sol.," 3d species is *M. undata*; 2d species is now *Merulina ampliata*).

Undaria Oken, Lehr. Naturg., p. 68, 1815 (includes 1st, *agaricites*; 2d, *undata*).

Agaricia (*pars*) Lam., Hist. Anim. s. Vert., 1815.

Agaricia (subgenus *Mycedia*) Dana, Zooph., pp. 333, 335, 1846 (*non Mycedium* Oken, 1815).

Agaricia and *Mycedium* (*pars*) Edw. and Haime, Corall., iii, pp 72, 80, 1860 Duch. and Mich., Cor. Antill , pp. 80, 81, 1860.

Agaricia Quelch, Voy. Chall., Zool., xvi, p. 116. Gregory, op. cit , p. 279, 1895. Vaughan, op. cit., p. 63, 1901.

This genus cannot be divided into two, on account of the character of the unifacial or bifacial corals, as many writers have tried to do, nor on the character of an encrusting mode of growth, as distinguished from the *pedicelled*, cup-shaped or turbinate, and foliaceous corals, formed by several of the species, and perhaps by all under certain conditions, and when young. Better generic and specific characters are to be found in the finely striated under side of the coral, when it is free, and in the distinctly stellate calicles, usually arranged in concentric lines or grooves, often separated by ridges or collines, around the primary calicle, but this arrangement may become irregular, obscured, or wholly lacking, in parts of very old or crowded specimens of some species, like *A. agaricites*.

The septa are but little prominent, usually in two to four cycles, and are usually finely and rather evenly serrulate. The calicles are usually rather small or of moderate size, much larger and far more distinctly stellate than in *Pachyseris*, but not so large and prominent as in *Mycedium* (true sense). The septa and costæ are not coarse and not spinose, nor lacerately toothed, as in the latter.

The calicles often resemble those of some species of *Pavona*† very closely and so does the frondose structure of the coral.

The mistake of confounding true *Mycedium* with this genus has already been discussed above (pp. 133–135).

* I take *A. undata* as type, because there is still much doubt as to the real affinities of *cucullata*. The latter has been identified with *M. elephantotus* by many, and hence put under *Mycedium*. *A. undata* is evidently closely allied to *A. fragilis*. The original type is still in the Hunterian Mus. (t. Young, Ann. Mag. N. H., xix, p. 116, 1877).

† *Pavona* Lam., 1801, p. 372, but spelled *Pavonia* Lam., 1816; Dana, 1840, etc. The two examples given, in 1801, were 1st, *P. cristata*, with reference to Ellis and Sol., pl. 63; 2d, *P. lactuca* (Pallas). Edw. and Haime, Corall., iii, p. 81, 1860, and Gregory, op. cit., p. 279, 1895, quote *P. cristata* Lam., 1801, as a synonym of *Agaricia agaricites*. If this were so, then *Pavona* and *Agaricia*

Much confusion has always existed as to the number and characters of the species included in this group. Gregory and Vaughan, among recent writers, have gone too far in uniting diverse species, so as to reduce the number of American species to two or three only. Gregory (op. cit., pp. 279, 280) united with *agaricites*, not only *cristata*, but also *undata* (E. and S.); *purpurea* Les.; *gibbosa* D.; *Lessoni* D. and M.; *vesparium* D. and M.; and even "*A. arthrophylla*" Horn.* (i. e. *anthophyllum*), which has no resemblance to *agaricites* and belongs to *Pachyseris*. Probably some of the other species that he lumped together, perhaps rather hastily, may also be distinct.

Vaughan (op. cit., 1901) followed Gregory pretty closely, but was inclined to keep *fragilis* and *elephantotus* separate, and he was doubtful about *anthophyllum*. But under *agaricites* he puts *Lamarcki*, *Danai* (D. and M.), and with doubt, *Sancti-Johannis* D. and M. He has studied the types of *Danai* D. and M.; *Lessoni;* and *vesparium* at Turin, and his opinion is important as to these. But the *Danai* and *Sancti-Johannis* are referred to the *elephantotus-fragilis* group by Gregory.

This genus is almost exclusively West Indian, but *A. Forskalli* Edw. and H. is a fossil from the recent deposits of the Red Sea. Quelch (Voy. Chall., xvi, p. 118) described *Agaricia regularis* from Levuka I. In the Indo-Pacific fauna it is mostly replaced by *Pavonia* and *Pachyseris*, with numerous species.

would be synonymous. But Edw. and Haime refer the *M cristata* of Ellis and Sol. to *Lophoseris* (op. cit., p. 66), which is synonymous with *Pavonia* of authors. So the reference, first named, is doubtless an error. On the same page "*Madrepora agaricites* Dana" is quoted, by error. The original definition of *Pavona* would apply equally to that genus and to some species of *Agaricia*, like *A. agaricites*. *Agaricia* was then separated wholly on account of the unifacial coral—a character of minor importance.

* *Pachyseris anthophyllum* (Horn, 1860) Ver. The type of this species was studied by me in the Philadelphia Acad. Nat. Science a number of years ago. It is a typical *Pachyseris*, closely allied to *P. monticulosa* Ver., and is doubtless of Indo-Pacific origin, like all the related species. The surface is covered with lobes and monticules, much as in certain examples of all the other species. The septa are laterally covered with numerous close and prominent, rough or crisped, flat or irregular granulations, which fill up much of the space between them, the granulations being often nearly in contact across the interseptal spaces, giving the septa a crowded and thickened appearance, though the septa themselves are rather thin for the genus, and alternately unequal. The ridges or collines are somewhat irregular, obtusely rounded, or somewhat angular, not very elevated, nor very close together. The calicinal centers are indistinct. The calicinal groove is narrow and deep, and contains a columella-lamella of variable thickness. The under surface of the frond is finely and regularly costulate.

Agaricia fragilis Dana. Hat Coral. Shade Coral

Agaricia (*Mycedia*) *fragilis* Dana, Zoöph. U. States Expl. Exp., p. 341, 1846.
Mycedium fragile Verrill, Bull. Mus. Comp. Zoöl., i, p. 55, 1864. Pourtalès, Deep Sea Corals, pp. 48, 82, 1871. Florida Reefs Corals, pl. xi, figs. 1-10 (series of young), pl. xiii, figs. 1-5 (adult), pl. xiv, figs. 1-9 (details), 1880.
Mycedia fragilis Edw. and Haime, Corall., iii, p 83, 1860.
? *Agaricia Lamarcki* and ? *A. undata* (*non* Ellis and Sol) Edw. and Haime, Hist Corall., iii, pp. 82, 83, 1860
Agaricia fragilis Quelch, Challenger Voy., Zoöl , xvi, p. 116, 1886 Vaughan, op. cit., p. 67, 1901.
Agaricia elephantotus (*pars*) Gregory, Quart Journ. Geol. Soc. London, li, p. 280, 1895 (*non* Pallas).

Plate XXVI. Figures 1*a*-1*d*

This elegant species has been so fully and beautifully illustrated by Sonrel in the plates of the Florida Corals Reefs, by Louis Agassiz, edited by Pourtalès, quoted above, that little need be added, except as to its synonymy and habits, and some special variations. It is the *only* species of *Agaricia* found at the Bermudas, where it is very common in very shallow water, as well as in two to four fathoms. So that Gregory's idea that it is a deep water variety is not valid. In Harrington Sound, where there is scarcely any tide, it can often be gathered by hand from water not over a foot deep, especially under the shade of overhanging cliffs, but it is most abundant in six to twelve feet of water. It generally lives in sheltered localities, where heavy surf does not occur. It often occurs in colonies.

In the spring of 1901, many recently dead and partly dead specimens, mostly of large size, were seen in Harrington Sound. This was due, without doubt, to a period of unusually cold and stormy weather in February and March, which also killed vast numbers of fishes, etc., in Bermuda waters.*

No forms like *M. elephantotus*, nor like *A. agaricites*, are ever found here, which is good evidence that they are distinct and more tropical species.

Hundreds of specimens from Bermuda, studied by me, show but slight variations, aside from those due to ordinary growth and to injuries. The specimens here are always pedicelled, with a broad, thin, delicate, cup-shaped, saucer-shaped, or salver-shaped frond, when normally grown ; rarely the edges bend down all around, and the upper side may then be flat or concave. After injuries the frond may become irregular, or even much deformed, owing to unequal repairs, but it never becomes truly encrusting.

* See Amer. Journ. Sci., xii, p. 88, 1901.

In some instances the coral has been penetrated by the double siphon-tubes of *Gastrochæna*, which may rise one to two inches above the upper surface. In such cases these tubes become covered to the tips with an encrusting growth of the coral, as is usual with corals of this and other groups, thus forming conical or chimney-like structures. These are the only instances in which I have seen this species assume, even in a small part, an encrusting mode of growth, but this does not affect the general form of the frond.

This coral does not become thick, except close to the region of the pedicel. Frequently, bilobed specimens occur, with two primary or large calicles around which the concentric circles of calicles have been formed (see pl. xxvi, fig. 1c). Large specimens at Bermuda are sometimes a foot across, but these are usually deformed, owing to injuries. Perfectly regular specimens are seldom more than half that size (150^{mm})

Sometimes two or more specimens, coming in contact when young, graft themselves together by their edges, which are always very thin and fragile.

The calicles are always small, generally with their edges somewhat elevated. They are always plainly stellate. The septa and costæ are thin, nearly even, and finely serrulate. The collines vary considerably in height and the distance between them, but they are generally long, rather regular, rounded, and not much elevated, the calicles being mostly in long concentric series, but frequently they are isolated or form short series. The color of the animal, in life, is rich chocolate-brown or purplish brown. The tentacles are whitish, very small and short.

In respect to the size of the collines, this species often resembles the figure of *A. undata* in Ellis and Sol. But that figure represents a coral with less defined and smaller calicles, and having a thicker frond, quite unlike the delicate fronds of this species. Of course this may have been due to the fault of the artist, but the plates of that work are generally pretty accurate. Hence I believe it to be a distinct, much larger, and more massive species, probably inhabiting deeper water.* The type is still extant. See p. 140, note.

* It is doubtful whether many recent writers have seen specimens of the true *A. undata*, though Pourtalès said that he had seen it in Cuba. I am not sure that I have myself seen a specimen that I could refer to that species with confidence But that does not prove that such a species does not exist. I have studied large numbers of undescribed West Indian Alcyonaria from moderate depths. Numerous unknown or rare corals are probably to be found in those waters The early collections often contained rare and little known species, seldom seen in modern collections. Some of these were doubtless brought up on anchors or on the hooks of fishermen, a prolific source for obtaining rarities in all seas

Dana (Zoöph., p. 336, pl. xxi, fig. 8) refers to two large specimens of *undata* that he had seen. One of these was in the American Museum, New York. The other in the Mus. Acad. Nat. Sciences, Philadelphia. I have been unable to find either of these specimens, but there is an unpublished sketch of the latter, by Dana, in the Yale Museum. Dana states that it was 15 inches long and 8 broad. The former was 18 by 12 inches, and was from Key West.

The "American Museum" referred to is not the present museum of that name. It was a small private museum that was destroyed by fire many years ago.

The coral described by Edw. and Haime (Hist., ii, p. 83) as *A. undata* does not seem to me to be the *undata* of Sol. and Ellis. It was described as very thin and fragile (thickness of frond 2^{mm}). The calicles are in series, separated by small, distinct collines, but they have only 10 to 12 septa, and are smaller than those of *fragilis*, the diameter being 1.5^{mm}. It is evidently near the latter and may be only a variety of it with smaller calicles and fewer septa than usual. *A. fragilis* usually has 15 to 20 septa, sometimes 24. But in the absence of a figure, it is hardly possible to decide this question, without a reëxamination of the type.

A. Lamarcki Edw. and Haime (Hist., iii, p. 82)=*A. undata* Lam., 1816, *? non* Ellis and Sol., has been placed as a synonym of *agaricites* by Vaughan, but according to the original description it agrees pretty closely with *fragilis* and *undata*. It was described as growing in a thin (7–8^{mm} thick), expanded frond, undulated and very finely costellate below, and with broad, low, obtuse, unequal, concentric collines above. Calicles numerous and close, 2^{mm} broad, with 16–20 septa, and a large columella; septa pretty thin, close, very finely denticulated. Collines 19^{mm} apart.

This description applies very well, in many respects, to some specimen of *fragilis*, though the thickness of the coral is rather too great. In this respect and others it seems to be more like the true *undata* Ellis and Sol., where Lamarck placed it. Vaughan does not say that he saw the types of either of the last two species. Had he studied the types, his opinion of these species would be entitled to great weight, in each case. The *undata* Dana is another species.

A. Danai (Duch. and Mich.), *non* Edw. and Haime, was placed by Gregory under his *elephantotus-fragilis* group. But by Vaughan (from types) it was put under *agaricites*. Quelch (op. cit., p. 116) puts it down as a thick variety of *A. fragilis*. It forms a thick and solid, largely free frond, adherent at the center, but the original

description is very brief and poor, giving no account whatever of the calicles, septa, costæ, etc. I have seen examples of *agaricites* growing in the same form, but the same is true of *A. purpurea*.

The name was preoccupied by Edw. and Haime (Corall., ii, p. 84), who applied it to *A. cristata* Dana (*non* Lam.). This last belongs to the frondose *agaricites*-group. A part of the type is still in the Yale Museum (see p. 146, fig. 6, and pl. xxvii, fig. 5).

Gregory also makes the same disposition of *M. Sancti-Johannis* and *A. frondosa* Duch. and Mich. But Vaughan refers the former doubtfully to *agaricites* (types not seen). He does not mention *frondosa* D. and M.; Quelch thought it distinct. (See p. 149.)

Mr. Gregory also studied the types of some of the species of Duch. and Mich., at Turin, but unfortunately he does not state which particular species he examined,* so that one cannot tell whose opinion has most value, as in the cases cited above, when he and Mr. Vaughan disagree.

Agaricia crassa Ver., sp. nov. "Pineapple Coral."

PLATE XXX. FIGURE 6. PLATE XXXIV. FIGURE 2.

Coral massive, very heavy, forming compact, spheroidal or hemispherical masses, up to 150^{mm} in diameter and 100^{mm} thick, covered with areolated and reticulated collines.

Calicles deep, rather crowded, $2–3^{mm}$ in diameter, with about 30–36 rather thin, finely serrulate, scarcely exsert septa; the 12 larger ones vary but little in thickness and alternate with narrower and slightly thinner ones. Many calicles are isolated or in short rows of two to six. The collines, which are variable in height, form curiously and intricately reticulated patterns, consisting of angular or rounded areas, bounded by high, acute collines, each enclosing numerous smaller, sunken areas of various sizes and shapes, bounded by lower, irregularly reticulated collines. Exotheca and walls, in sections, nearly solid; endotheca cellular, with numerous transverse dissepiments; columella solid.

Bahamas (coll. R. P. Whitfield), six or seven specimens, all much alike; Amer. Mus., No. 514; and Yale Museum, No. 6617.

* Mr. Gregory states also (op. cit., p. 256) that he examined the collection in the Yale Museum. Unfortunately his visit to New Haven was made in vacation, when I was not in town. Apparently he overlooked various type of Dana which were in the cases that were opened for him. His examinations were very brief. See p. 114.

Agaricia agaricites (L.) E. and Haime.

Madrepora agaricites (*pars*) Linné, Syst. Nat., ed. x, p. 795, 1758; ed. xii, p. 1274, 1767. Pallas (*pars*) Elench. Zoöph., p. 287, 1766. Ellis and Sol., Zoöph., p. 159, pl. lxiii, 1786. Esper, Pflanz., i, p. 182, 1789.

Undaria agaricites Oken, Lehrb. Nat., p. 69, 1815.

Pavonia agaricites Lam., Hist. Anim. s. Vert., ii, p 239, 1816

Agaricia (*Mycedia*) *agaricites* Dana, Zooph., p. 342, 1846.

Agaricia agaricites Edw and Haime, Ann. Sci. Nat., xv, p. 127, 1851; Hist. Corall., iii, p. 81, 1860. Pourtales, Deep Sea Corals, p 82, 1871; Florida Reefs, pl. xi, figs. 11–13, pl. xii, figs. 1–3, 1880.

Agaricia agaricites (*pars*) Gregory, op. cit., p. 279, 1895 (synonymy). Vaughan, op. cit., p. 64, 1901.

Agaricia (*Mycedia*) *gibbosa* Dana, Zoöph., p. 341, 1846 (var. from type).

Agaricia (*Mycedia*) *cristata* Dana, Zoöph., p. 343, 1846 (large celled var., from type), and var. *tenuifolia*.

Agaricia Danai Edw. and Haime, Corall., iii, p. 84, 1860=*cristata* Dana, *non* Lam. (*non Mycedium Danai* Duch. and Mich., 1860). Large celled variety.

Mycedium Danai Duch. and Mich., Corall. Antill., p. 81, 1860 (t. Vaughan, from type,) *non* Edw. and Haime. Lamellate variety.

Mycedium Lessoni and *M. vesparium* Duch. and Mich., op. cit., p. 81, 1860, (t. Vaughan, from types). Reticulated, encrusting varieties.

? *Mycedium Sancti-Johannis* Duch. and Mich., op. cit., Supl., p. 187, 1866, (t. Vaughan, but not from types).

? *Agaricia frondosa* Quelch, op. cit., p. 118, 1886. (? *non* D. and Mich.).

Plate XXVI. Figures 2, 3. Plate XXVII. Figures 1–3, 5–7.

This species varies greatly in mode of growth and form, and also in the size of the calicles and their arrangement, and in the character and size of the collines, which are nearly abortive in some cases.

5 6 7

Figure 5.—*Agaricia agaricites*, var. *Danæ*. Part of a frond of a well-grown Bahamas specimen, natural size. Fig. 6.—The same. Part of the original type of Dana, natural size. Fig. 7.—*Agaricia agaricites*, var. *agaricites*. Part of a frond of a large, loculate, West Indian specimen, natural size.

Therefore it is natural that there should have been much confusion as to the limits of the species. It is even quite possible that two or more species are included in the above synonymy. Several of the forms referred to differ so much that no one would unite them did not intermediate specimens occur.

Hence it seems best to treat the following forms as varieties :

Variety *a.—agaricites.* Typical. Fig. 7.

PLATE XXVI. FIGURE 2. PLATE XXVII. FIGURES 7, 7*a*.

This usually has the base largely encrusting or attached, at first, but when larger it has more or less erect, crest-like, rounded or irregular, bifacial fronds, rising from the upper surface. Sometimes, in very large examples, these unite and form loculi. The edges of the basal part may be more or less free and unifacial, with the underside finely costulate. Calicles of medium size, when full grown mostly 2 to 3^{mm} in diameter, but variable on a single specimen. Septa usually 24 to 36, narrow, crowded, and subequal. Collines usually numerous, more or less developed, mostly transverse, or parallel with the edges of the fronds and crests, and mostly with angular or acute summits, but often reticulate. The valleys are angular, rather deep and narrow ; calicles plainly stellate, mostly in series, but often isolated or in pairs, and then usually pentagonal. Septo-costæ are small, numerous, closely crowded, finely and closely granulated, not conspicuously unequal, with very narrow spaces between them. Pourtalès (Florida Reefs, Corals, pl. xii, figs. 1, 2) gives excellent figures of this form.

It is common from Florida southwards. I have seen several specimens over a foot across, with frondose loculi, and folia over six inches high. A large and typical specimen of this variety 12 to 14 inches across and 8 to 10 high, from near Nassau, N. P. (coll. Whitfield), is in the Amer. Museum, New York. (Fig. 7, p. 146, No. 5671.)

Var. *b.—Danæ* E. and H. (*non* D. and M.);=*A. cristata* Dana. Figs. 5, 6.

PLATE XXVI. FIGURE 3. PLATE XXVII. FIGURES 5, 6.

This grows nearly like the preceding, but the coral is thicker and more massive, and the fronds are often very large and thick, usually rounded, with the edges bifacial and acute. The collines are usually strong and acute, often rising into sharp crests, but where the calicles are crowded on the basal parts, the collines may be nearly abor-

tive and some of the calicles may be in pairs or isolated, polygonal, and astreiform, separated only by angular walls. The principal distinction is in the much larger size of the calicles, which, when full grown, are usually 3.5 to 4^{mm} in diameter, and in the smaller number and marked inequality of the septa, the primary and secondary ones being thickened and so wide that they leave only a small central pit, while the smaller septa are much narrower and thinner, and are lacking in part of the systems. The columella is usually solid. Septo-costæ are strong, thin, conspicuously alternately unequal, not crowded, finely granulated No. 4301, type of Dana.

Florida Reefs, etc.; Yale Museum. Large frondose specimens, 12–15 inches broad and about 10 high, from the Bahamas (coll. Whitfield) are in the Amer. Mus., New York. Single fronds may be 225^{mm} wide; 200 high; 44 thick. No. 275.

Var. *c*—*gibbosa* (Dana)=? *vesparium* D. and M.

PLATE XXVII. FIGURES 1, 1*a*.

This forms irregular, encrusting, nodular or lobulated masses, without distinct crests. The common base, in the type, is free, striated, and unifacial for some distance, and the edge is thin. The collines are low, mostly reticulated, or very irregular, and often lacking. The calicles are in short irregular series, or isolated, and angular or astreiform. They are nearly as large as in var. *Danæ*. (See pl. xxvii, fig. 1, from type.) No. 1860.

Var. *d.*—*pusilla* V.=? *M. Lessoni* (D. and M.).

PLATE XXVII. FIGURE 3.

This form is almost entirely encrusting, often with the collines abortive, or nearly so, but when present they are small and near together, concentric or reticulated, rounded or obtuse. The calicles are generally irregularly arranged or in short series, crowded, and many are isolated; they are unusually small (mostly about 1 to 1.5^{mm}, rarely 2^{mm}) but otherwise they resemble those of typical *agaricites*. The septa are about 20 to 24, alternately unequal, rather thick, crowded. The small size of the calicles is the most important character. (Pl. xxvii, fig. 3.) No. 1489.

Var. *e.*—*tenuifolia* Dana (under *A. cristata*). Forms thin, foliaceous fronds; calicles small, 1.5^{mm} across, stellate, scattered, scarcely seriate, collines low, rounded. Similar to var. *d*, but foliaceous.

The relations of *Lamarcki*, which Vaughan refers here, have been discussed under *fragilis* (p. 144). If it really belongs to *agaricites*,

which I doubt, it should receive the variety name *Lamarcki* (E. and H.) on account of its thin, pedicelled fronds and small calicles.

A. frondosa (Duch. and Mich.) Quelch, is also a doubtful form, which Quelch thinks distinct. According to Quelch it forms solid crests ; the collines are irregularly arranged, close, and not acute. The calicles have about 30 septa, seldom more. This seems to me to be near *Danai* of Edw. and H.=*cristata* Dana (our var. *b*), but it may not be the same as the type of D. and Mich.

This common species and its varieties are found on the Florida reefs and throughout the West Indies to South America and Colon. From Colon I have received varieties *a, b, d.* They were all found in shallow water, under similar conditions. None of these forms have been found at Bermuda. A small form, near var. *d*, is found at the Abrolhos Reefs, Brazil, and a small, more nearly typical specimen near var. *a*, from Pernambuco, is in the Yale Museum.

Agaricia purpurea (Les.) Dana.

Agaricia purpurea Les., Mem. Mus Hist. Nat. Paris, vi, p. 276, pl. xv, fig, 8, *a, b, c*, 1820. Dana, Zoöph., p. 340, 1846 (unifacial variety).

? *Mycedium Danai* Duch. and Mich., Corall. Antill., p. [81], 1860 (*non* Edw. and Haime).

PLATE XXVII. FIGURES 4, 4*a*, 4*b*.

This species usually forms broad, thick unifacial fronds, generally attached near the middle or else partly encrusting. The fronds may be flat or cup-shaped. The collines are usually narrow, acute, short, and often irregular or reticulated. The calicles are large and open, deep, angular, often isolated, and deeply sunken between the sharp walls or collines. They are oblique and often so deep and curved that the wide bottom cannot be seen. The septa are thin and narrow, leaving a wide, open, central space, and wide spaces between them ; there are usually 24 to 36, alternately very unequal. (Pl. xxvii, fig. 4.)

In sections a small, solid, papilliform columella is present in some calicles, and there are well formed tabular dissepiments in the thicker parts, which extend quite across the calicles. The common wall is very solid, but it has some radial, angular cavities in the thick basal portion near the pedicel. The costæ of the under side are slender, pretty even, and regular.

This differs so much from the several varieties of *agaricites*, described above, that it seems probable that it is distinct. It is remarkable for the large and very deep, open, angular calicles, separated by rather thin, acute walls, and for the tabulate dissepiments.

The figured specimens are from Colon (Yale Mus.). They differ somewhat from Lesueur's type, in the size and depth of the calicles. This form may be distinguished as var. *faveolata* Ver. It was attached by a stout pedicel. No. 1201.

Agaricia nobilis Ver., sp. nov.

? *Mycedium elephantotus* Edw. and Haime, Hist. Corall., iii, p. 74, 1860. (Syn. excl., *non* Pallas sp.).

PLATE XXVIII. FIGURES 1, 2.

Coral grows in the form of broad, rounded, thin, foliaceous fronds, attached by a central pedicel. The frond may be flat, or concave, or variously bent and lobed, but when young and normal it is round and cup-shaped or salver-shaped. It is very hard and translucent, so that though very thin, especially towards the margins, it is stronger than most thin corals. The under side is finely and nearly evenly covered by fine costal riblets and striæ; these costæ are finely granulated on their edges.

The upper side is loosely covered with rather large, deep, prominent, appressed, stellate calicles. These are irregularly arranged; many stand singly; but most are in pairs, or series of three to six or more, in front of short, rather prominent, curved, obtuse-angled collines, having the longer proximal slopes concave and often lobulated, with swellings corresponding to each calicle. The short collines, when supporting one to three calicles, are crescent-shaped in outline, and look like curved brackets.

The calicles are inclined strongly outward, except those near the center; the central pit is rather large and deep, usually without a columella, but some of the calicles may have a small, solid, tuberculiform one.

The septa are alternately larger and smaller; usually there are 36 to 48 in the larger calicles, of which 16 to 24 are much the larger and thicker. The summits are prominent and angular; the inner edges of the outer septa descend abruptly, while those of the outer side are angulated at the top and concave above, and usually below, the angle. The edges of the septa are very finely serrulate or granulate.

The septo-costæ are of variable length, but usually rather long, especially towards the margin; their lengths are from 5 to 12^{mm} or more, but mostly about 10^{mm}. They are regularly alternately larger and smaller, the larger ones being distinctly thickened, while the smaller ones are thin and much lower. Their edges are very evenly, microscopically serrulate or granulate.

Breadth of the type, which is a single frond, 400^{mm} by 150^{mm}; thickness 5^{mm} to 0.5^{mm} or less; at 25^{mm} from the edge, about 1^{mm} thick; diameter of larger calicles, mostly 4 to 6^{mm}.

The type is from Turk's Island, W. I. (Mus. Yale University). It is a rare species in American collections. No. 850.

This is, perhaps, one of the species that have been confounded under the name of *elephantotus* Pallas, a very different East Indian species, and the type of *Mycedium* (see p. 134 above). The present species is destitute of the rough serrations and spinules of that species and differs in many ways, though it grows in a similar form. This may, however, be the *elephantotus* Edw. and Haime; but their synonymy does not apply to it.

Whether this is the form united to *A. fragilis* by Gregory under the name of *elephantotus* I do not know. Neither can I tell whether it be the *elephantotus* of Pourtalès, or of Vaughan (op. cit., p. 67), for they give no descriptions. But it is not the *elephantotus* of Oken, nor of Ehrenberg, nor of Dana, nor of Esper.

It is quite distinct from *A. fragilis*, though it grows in similar shaped, thin fronds. But the fronds of this species are much larger, thicker, and firmer. The calicles are much larger, more appressed, more prominent proximally, and much deeper. The collines are much shorter, larger, higher, and much more irregular. The septa and septo-costæ are also quite different.

Siderastræa siderea (E. and Sol.) Blainv.

Madrepora siderea Ellis and Sol., op. cit., p. 168, pl. xlix, fig. 2, 1786.

Astrea siderea Lam., Hist., ii, p. 267, 1816. Lesueur, op cit., p. 286, pl. xvi, fig. 14, 1820. Lamx., op. cit., p. 60, pl. xlix, fig. 2, 1824. Edw. and Haime, Hist. Corall., ii, p. 509, 1857. Gregory (*pars*), op. cit., p. 278, 1895.

Siderastræa siderea Blainv., op. cit., p. 885, 1830; Man. Actin., p. 370, 1834. Edw. and Haime, Monog., p. 141, 1849. Verrill, Bull. Mus. Comp. Zoöl., i, p. 55, 1864. Pourtalès, Reef Corals, p. 81, 1871. Vaughan, op. cit., p. 62, 1901. Verrill (*pars*), these Trans., x, p. 554, 1900.

Pavonia siderea Dana, Zoöph., p. 331, 1846.

Siderastræa grandis Duncan, op. cit., p. 441, pl. xvi, figs. 5*a*, 6, 1868, fossil, (t. Vaughan).

PLATE XXX. FIGURES 2, 3.

This coral forms large, compact, hemispherical masses up to 2 feet or more in diameter.

The calicles are usually deep, narrow at the bottom, and larger than in either of the other American species (usually $5–6^{mm}$ in greater diameter when full grown). They are angular, mostly pentagonal

or hexagonal, usually with a definite, raised, acute or subacute bounding wall between them, which may show as a thin zigzag line between the ends of the septa. Usually 3 or 4 rows of synapticulæ show on each side of the wall, between the septa, with conspicuous loculi between them.

The septa are in five cycles, the last cycle being incomplete. There are usually, in well formed calicles, 50 to 64 septa; the average number being about 58. But specimens often occur in which the number seldom exceeds 48 or 50.

The septa are finely serrulate and pretty even in height, though those of the different cycles can easily be distinguished by the gradations in breadth and thickness. Those of the last cycle are thin and often bend toward and join those of the preceding cycle. The columella is small, at the bottom of a small central pit. It usually consists of about 3 to 6 unequal papillæ.

It is very common on the Florida keys and reefs and throughout the West Indies. Also at Colon, Col. (variety *nitida*); and at the Bermudas (variety ?). It is hardy and can live in muddy situations, and where exposed at low tide, like *S. radians*, though it seems more partial to the reefs.

The Bermudian specimens that have been referred to this species, so far as I have observed them, are not of the typical form, and may be an extreme variety of *S. radians*. The calicles are not so large nor so deep as in the Florida form, nor are the septa so numerous, (about 42–48).

Var. *nitida* V., nov. Plate xxx. Figure 3.

The Colon specimens (Yale Mus.) are convex, encrusting plates. Their calicles are not quite so large as in the typical forms, and are much more shallow, while the bounding walls are less distinct, lower, and more rounded, so that the calicles seem less angular and more blended. The septa are numerous (about 50), crowded, and rather equal, giving the calicles a neat and even appearance. No. 1028.

When well grown this species seems quite distinct from *S. radians*. It has decidedly larger, deeper, and more angular calicles, which have more elevated and distinct walls. Usually there are about 5, sometimes 6, calicles to 2 centimeters, when in rows. The septa are more numerous (usually 50 to 60) and more equal in elevation.

But impoverished specimens occur, which are not always easy to distinguish from some of the varieties of *S. radians*.

For the reasons for retaining *Siderastræa* as the name of this genus, see above, pp. 88, 89.

Siderastræa radians (Pallas) Ver.

Madrepora radians Pallas, Elench. Zooph., p. 322, 1766.

Madrepora galaxea Ellis and Sol., Zoöph., p. 168, pl. xlvii, fig. 7, 1786.

Astrea galaxea Lam., Syst., p. 371, 1801; Hist., ii, p. 267, 1816. Lesueur, op. cit., p. 285, pl. xvi, fig. 3, 1820. Lamx., op. cit., p. 60, pl. xlvii, fig. 7, 1821.

Astrea radians Oken, Lehr. Nat., p. 65, 1815.

Astrea (Siderastrea) galaxea Blainv., Dict. Sci. Nat., lx, p. 335, 1830; Man. Actin., p. 370, 1834.

Astræa radians Edw. and Haime, Hist. Corall., ii, p. 506, 1857. Gregory, op. cit., p. 277, 1895.

Siderina galaxea (*pars*) Dana, Zooph., p. 218, pl. x, figs. 12, 12*b*, 12*c*. (Type examined.)

Siderastræa galaxea Edw. and Haime, Ann. Sci. Nat., xii, p. 139, 1850. Pourtalès, Reef Corals, p. 81, 1871; Florida Reefs, pl. xi, figs. 14–21, young, pl. xv, figs. 1–12, 1880. Quelch, op. cit., p. 113, 1886.

Siderastræa radians Verrill, Bull Mus. Comp. Zoöl., i, p. 55, 1864; Coral Reefs and Islands, p. 380; ed. 3, p. 421. Vaughan, op. cit., p. 61, 1901.

PLATE XXX. FIGURE 1.

This coral usually forms rounded spheroidal or hemispherical masses, which may become 12 to 15 inches (400 to 500^{mm}) in diameter; but it is often encrusting, especially when young, and it often grows in broad irregular masses; not infrequently it is almost globular and lies loose on the bottom, with calicles developed on all sides. Such loose masses are most commonly 2 to 5 inches (50–125^{mm}) in diameter. They were doubtless all attached when very young, but perhaps only to small bits of shell, etc.

The calicles are deep in the center and small, their diameter when full grown is mostly 2.5 to 3.5^{mm}, the average size being about 3^{mm}, rarely 4^{mm}. They are angular with rounded corners, and usually appear as if separated by thick walls, owing to the low rounded summits of the walls, which are, however, actually rather thin, with one or two rows of small synapticulæ showing on each side.

The septa are decidedly unequal in width and thickness, those of the first two cycles standing out very plainly from the others. They form three complete cycles, with part of the fourth cycle developed, so that the number is usually 36 to 40, in the larger calicles, (rarely 48). But the size of the calicles and the number of septa vary considerably on a single specimen, according to the amount of crowding, or the rapidity of growth.

The septa are closely arranged, with very narrow loculi. The larger ones are wide, broadly rounded, somewhat exsert, with all the edge pretty evenly serrulate, though the distal serrations are apt to be rather larger. The six primaries are distinctly larger than the

secondaries, and those of each cycle are successively narrower and thinner; all are nearly straight and seldom united. The proximal half of the inner edge is nearly perpendicular, thus producing a deep central pit. The columella is small and papillose.

The polyps are but slightly exsert; the tentacles are small, short, cylindrical, or clavate; they form several circles, and appear somewhat scattered, those of successive cycles being in different circles and decreasing in size.

But they are not bilobed, nor trilobed, as Agassiz and Pourtalès supposed.* This appearance is due to a smaller one standing on one or both sides of a larger one, and close to it.

The general color in life is dull gray, yellowish gray, ocher-yellow, or rusty brown, sometimes tinged with a purplish rosy tint; the polyps are paler, with the lips and tips of the tentacles whitish.

This species, which is abundant at the Bermudas, is more hardy than most reef corals, for it can live and grow well in shallow water on mud flats, where it is laid bare by nearly every tide, and where most other corals would be smothered in the mud, though *S. siderea* and some forms of *Isophyllia fragilis* are usually found with it in such places.

It is often partly buried in the white calcareous mud of the flats, and yet seems healthy there. It is also abundant in the small, shallow pools left on the flats by the tide. But it is equally common on the reefs, where it often grows larger. It is also found well grown in Harrington Sound.

Exposure to the dry air, or even to the hot sun, for an hour or so, does not kill it, if it be wet beneath. Probably its porosity enables it to absorb sufficient water to prevent drying up.

It is equally common on the Florida reefs and flats, and throughout the West Indies to South America and Colon.

The decidedly smaller size of the calicles, fewer septa, and the conspicuously larger primary and secondary septa serve to distinguish this species from *S. siderea*.

But it varies considerably in all these characters, so that some specimens may occur that seem almost intermediate between the two species. In all such cases the *average condition* of the full grown calicles must be considered as of primary importance.

* The observations of Prof. L. Agassiz on the polyps of this genus, in 1850, and his figures in "Florida Reefs," pl. xv, figs. 1–7, relate to *S. radians*. In my note on this subject (these Trans., x, p. 554, 1900), I referred to it under *S. siderea*. But my studies of the polyps included both species. They are very similar, but *S. siderea* has larger polyps and more tentacles.

New buds appear chiefly between the angles of the calicles. Fission of the larger calicles occurs occasionally.

Siderastræa stellata Ver.

These Trans., i, p. 352, 1868. Rathbun, R., Amer. Naturalist, xiii, p. 541, 1879, (habits) Vaughan, op. cit., p. 62, 1901.

PLATE XXX. FIGURES 4, 5.

This species is related to *S. radians* and has the same ability to endure impure shallow waters and exposure to the air and sunshine, without injury.

It is widely distributed on the coast of Brazil ; Bahia, Abrolhos Reefs, etc.,—coll. C. F. Hartt ; R. Rathbun.

I have figured one of the types, from a photograph. No. 1464.

Var. **conferta** Ver., op cit., p. 353

PLATE XXX. FIGURE 5.

This peculiar Brazilian form has not yet been figured. Therefore I have reproduced a photographic figure of one of the types,—the extreme form. No. 1464*a*.

Asteroseris Verrill.

This genus seems to be related to *Plesioseris* Duncan.*

Dana described in 1846 a rare, thin, laminar or foliaceous coral (*Agaricia planulata*) that is the type of this genus.

I have studied a fragment of the original type, which is here figured (pl. xxvii, fig. 8). No. 4309.

The genus is remarkable for the low, reticulated collines, enclosing polygonal areas in which there are usually two or several stellate calicles. Each of these groups consists of a parent calicle from which the others around it have been produced as buds from it. These calicles of a group are not at first separated by definite boundaries, the costæ being continuous from one to another. Columella is a minute tubercle, or is lacking. Under side naked, finely striated. Calicinal walls solid. Synapticula and trabeculæ few or lacking.

The type of that genus (*Mæandroseris Australiæ* Rouss., from Australia) is a convex, gibbous, encrusting coral. But as both encrusting, massive, and foliaceous species occur in allied genera (*Pavonia*, *Agaricia*, etc.), it is possible that they might also occur

* *Mæandroseris* (*pars*) Rousseau, Voy. Dumont d'Urville, Zool., v, p. 121, 1854. Edw. and Haime, Hist. Corall., iii, p. 61, 1860. *Plesioseris* Duncan, Jour. Linn. Soc., Zoöl., xvii, p. 309, 1883 ; Revision Scler. Zoanth., op. cit., xviii, p. 161, 1884.

in this. But the type of *Plesioseris* has distinct synapticula and a well developed papillary columella, which are not found in our genus.

The resemblance to the fossil genus *Oroseris** is very close, in the form and mode of grouping of the calicles, and in the low, irregular collines, as well as in the foliaceous form of the coral. But *Oroseris*, according to Duncan, does not have solid mural and colline walls, these parts, as seen in sections, being trabecular. Were it not for this character, I should have considered this coral a living species of *Oroseris* or *Comoseris*, which it certainly closely resembles.

The grouped arrangement of the calicles is somewhat like that of *Polyastra venosa* Ehr.,† p. 106, 1874, but the latter seems to form a massive, astreiform coral. It is, however, only imperfectly known, the description being very incomplete and without a figure.

The form, general appearance, and the characters of the septo-costæ are somewhat like those of *Pachyseris*, but the latter does not have stellate calicles and its collines are much larger and more regular.

Asteroseris planulata (Dana) Ver.

Agaricia (Mycedia) planulata Dana, Zoöph., p. 338, 1846.

Agaricia ? planulata Edw. and Haime, Hist Corall., iii, p. 84, 1860.

Asteroseris planulata Verrill, in Dana, Coral Islands, ed. i, p 388, 1872, ed. 3, p. 424, 1890.

Plate XXVII. Figure 8.

The type specimen was a broad, thin frond, half a line thick, attached only at one point. Dana states that it was in the Museum of the Lyceum of Natural History, Utica, N. Y.

A fragment of this specimen, used by him for figuring the details, and now preserved in the Yale Museum, affords the following description :—

The calicles are polygonal and very shallow or superficial, being only slightly concave, except at the minute central pit, which is deep ; they are about 4 to 4.5^{mm} broad when full grown, but many are only 2 to 2.5^{mm}. They are often placed singly, with a slightly raised solid wall over which the septa are confluent and in part

* *Oroseris* Edw. and Haime, Pol. Foss. Palæoz., p. 130, 1851 ; Hist. Corall., ii, p. 78, 1860.

† This genus is probably identical with *Tichoseris* Quelch, (Ann. and Mag. Nat. Hist., xiii, p. 295, 1884). The type of the latter is an astreiform coral from the Fiji Islands.

geniculate; many are in pairs, either equal or unequal, due to immediate budding; others form small groups of three to five, evidently resulting from budding from the larger one of the group. Such groups are surrounded by low, solid, reticulating collines, only a little larger than the walls around isolated calicles, and arranged without order. Rarely the calicles are in short rows of three or more.

The septa are numerous (24 to 36), very close, thickened, especially toward the inner ends, and closely, finely granulated or crispate on the sides, as in *Pachyseris;* their exposed, nearly horizontal edges are minutely and roughly serrulate or granulate, but the inner ends of the larger ones descend nearly perpendicularly at the minute central pit, and this portion, as seen in section, is rather regularly and finely serrulate. The septa are very unequal and form four pretty regular cycles, sometimes with some of a fifth cycle. The primary and secondary ones are decidedly larger and thicker than the others and most of them reach the central pit, but the secondaries are a little the shorter and thinner; those of the third and fourth cycles are successively shorter; the smallest are very short and extend inward only a short distance in some of the systems, but are often quite long and curved in the lateral systems. All the septa rise to about the same level. The columella, when present, is a minute solid tubercle, or sometimes two.

The under side is naked, with small concentric undulations, and also with shallow radial valleys, between which the surface is slightly convex; these convex parts are covered with fine, divergent radial striæ, which run obliquely to the valleys on either side in a fan-like manner.

These costal striæ are only slightly raised, closely crowded, and distinctly granulated. In vertical sections the coral is nearly solid, except close to the upper surface. The interseptal spaces fill up very quickly with a solid deposit and the interseptal walls are thick and solid.

The original type, according to Dana, was a thin frond ten inches broad and one-eighth of an inch thick. Thickness of the fragment, described above, 3 to 5^{mm}. The habitat is unknown, but it is probably Indo-Pacific.

The *Merulina ampliata* (E. and Sol.) Ehr. was included in the West Indian fauna by Duch. and Mich. (op. cit., p. 80, 1860), but not as from personal observation. It is found only in the Indo-Pacific region, like all the other species of the genus.

Family **Poritidæ** Dana, 1846.

Poritinæ (subfamily) Edw. and Haime, Corall., iii, p. 173, 1860
Poritidæ Verrill, these Trans., i, p. 503, 1867.

Corals very porous, branched, encrusting, lobulate, or massive, increasing chiefly by budding. Calicles mostly small, shallow, stellate, circular, or angular, usually all of one kind, closely united, or not separated by much cœnenchyma, sometimes without evident walls. Septa more or less perforated, or fenestrate, often imperfect, mostly 12 to 24. Pali often present. Dissepiments few, sometimes tabulate. The calicles are generally all equal, but in some species of *Porites* a few larger ones, with more than 12 septa, appear irregularly and may divide by fission. The branches do not have a large leading or axial zoöid. Polyps much exsert in expansion. Tentacles 12–24, rarely more.

Porites polymorpha Link.

Madrepora porites (*pars*) Pallas, Elench. Zoöph., p. 324, 1766. Linné, ed. xii, p. 1279, 1767. Ellis and Sol., p. 172, pl. xlvii, figs. 1, 2, 1786.
Porites polymorphus Link, Besch. Nat. Samml , Rostock, p. 162, 1807.
Porites clavaria Lam., Hist. Anim. sans Vert., ii, p. 270, 1816. Dana, Zoöph., p 554, 1846. Edw. and Haime, Corall., iii, p. 174, 1860. Pourtalès, Florida Reefs, pl. xii, figs. 4-6, 1880. Rathbun, Proc. U. S. Nat. Mus., x, pp. 356–361, pl. xvi, pl. xvii, fig. 2, pl. xix, fig 1, 1887. Gregory (*pars*), op cit., p 282, 1895.
Porites porites Vaughan, op. cit., p. 73, 1901.

Plate XXXI. Figures 3, 3*a*.

The above synonymy includes only the leading references to the more typical form generally called *P. clavaria* Lam. Mr. Gregory has given a very full list of references to this and the other branched forms of West Indian *Porites*, all of which he masses together under the name of *P. clavaria*. Mr. Vaughan (op. cit., p. 73) also gives some additional synonyms and localities.* No doubt too many "species" have been named, but I very much doubt whether they should all be united into one species. However, I do not propose to discuss that question at this time.

* Mr. Vaughan states that he has examined the type of *P. nodifera* Klunz., and found it identical with *P. clavaria*. He thinks, like Rehberg, that the locality "Red Sea" is due to a wrong label. He also unites *P. valida* Duch. and Mich. with this species.

But, as having an important bearing on the subject, I will state that while *clavaria* (auth.), growing in irregular, stout-branched clumps, is abundant at the Bermudas, in a variety of stations, both in shallow water and on the reefs, and also in Harrington Sound, *P. furcata* has never been found there by me, nor by others so far as I can learn. This would certainly indicate that the latter is a distinct species, with a different physiological nature, or with a different embryology. It either requires warmer water, or else its free-swimming larvæ are too short-lived to reach the Bermudas in the northward currents. Were the two forms the same species, differing merely in form of growth, due to environment, they should both be found at the Bermudas, for the conditions are varied there.

Mr. Richard Rathbun (op. cit., 1887) has very fully described and figured most of the various varieties of these two species.

As for the name of this species, I cannot follow Vaughan in adopting *Porites porites* for it, for such a course would be contrary to the ordinary principles of elimination, which he, himself, employs in similar cases.

It is true that Pallas and all writers previous to Link (1807) included nearly all the species of *Porites* then known under the name *Madrepora porites*, which was a collective or generic group. Esper eliminated one species as *M. conglomerata*, and another as *M. arenosa*. Link eliminated another, the present form, by naming it *polymorphus*. Therefore, the specific name *porites*, if used at all, should be applied to one of the remaining species of those mentioned by Pallas, as varieties.*

* Pallas mentions *first* in his description (p. 324) a massive, gibbous species "massæ, gibbæ, tuberosæ, tunicatæ," and on p. 325, "Notæ," he speaks first of "massas informes, gibbas," "ex India," with stars subequal to those of *Mad. astroites* = *Orbicella annularis*.

This East Indian, gibbous, massive species, with large stars, was, without much doubt, a *Rhodaræa*, probably *R. calicularis* (Lam.) E. and H., but possibly the Chinese and East Indian form named *R. Lagrenei* E. and H. (diameter of calicles 4^{mm}), which may not be distinct from the former.

Therefore, it seems to me best to restrict *porites*, as a species, to the former and call it *Rhodaræa porites*, thus avoiding the repetition of *porites* and conforming with the principle of recognizing prior eliminations at one and the same time. None of the species of true *Porites* have the "stars" much more than 1.5^{mm} in diameter, rarely 2^{mm}.

Porites astreoides Lam.

Madrepora porites (*pars*) Pallas, Elench. Zoöph., p. 324, 1766.

Porites astreoides Lam., Hist. Anim. sans Vert., ed. 1, ii, p. 269, 1816; ed. 2, ii, p. 435, 1836. Lamx., Expos. Meth., p. 651, 1824, (*non* Ehr., 1834).

Porites astroides Lesueur, Mem. Mus. Hist. Nat., Paris, vi, p. 287, pl. xvi, fig. 15, 1820. Edw. and Haime, Hist. Corall., iii, p 178, 1860.

Porites astræoides Dana, Zoöph. U. S. Expl. Exp., p 561, 1846. Verrill, Bull. Mus. Comp. Zoöl., i, p. 42, 1864. Pourtalès, Reef Corals, Mem. Mus. Comp Zoöl., ii, p. 85, 1871; Florida Reefs, pl. xvi, figs. 1–12, 1880. Quelch, Voy Chall., xvi, pp. 11, 13, 182, 1886. Rathbun, Catal., Proc. U. S. Nat. Mus., x, p. 354, 1887. Gregory, op. cit., p. 284, 1895, (synonymy).

Porites superficialis, *P. incerta*, *P. Guadalupensis*, and *P. agaricus* Duch and Mich., Corall. Antilles, pp. [82, 83] 358, 359, 1860 (t. Vaughan from types)

Neoporites littoralis, *N. superficialis*, *N. Guadalupensis*, *N. agaricus*, *N. incerta* Duch. and Mich., Supl. Corall. Ant., pp. 191–193 [97–99], 1866 (t. Vaughan from types).

Neoporites Michelini, *N. astræoides*, *N. subtilis*, and *Cosmoporites lævigata* Duch. and Mich., op. cit., pp. 192, 193 [98, 99], pl. x, figs. 7–10, 12, 16, 1866 (t. Vaughan, but types not examined).

Porites Collegniana Duncan, Quart. Jour. Geol. Soc. London, xix, p. 437, 1863; xxiv, p. 25, 1868 (t. Vaughan from types, fossil).

Porites astreoides (*pars*) Vaughan, op. cit., pp. 74–77, 1901.

PLATE XXXI. FIGURE 4.

This coral is encrusting when young, but it soon forms thick rounded masses, with more or less raised lumps or low nodules over the surface, but it never becomes branched. It may form masses 2 feet or more in diameter.

When living its color is usually lighter or darker yellowish brown, or dull brownish yellow; sometimes it is yellowish gray, or even bluish gray.

The calicles are larger, deeper, and more distinct than in *P. clavaria*, and their walls are higher, thicker and more distinct at the surface. The 12 septa are also more distinct and less porous. The columella is rather small and porous, often with a small, central, irregular papilla, which may be lacking and is easily broken. The interseptal loculi are rather large and deep for this group. Small paliform papillæ are sometimes present, but more often are absent or rudimentary. The inner tooth or lobe of the septæ is often very distinct, erect, and paliform. The upper part of the wall is thin and divided into small, rough, flat denticles at the edge, higher than the septa, but it becomes thicker and rather solid a little farther down.

Well-formed calicles are from 1.25 to 1.50^{mm} in diameter; when in series there may be about 6 to a centimeter.

It is abundant both in shallow water and on the reefs at the Bermudas. It also occurs even in Harrington Sound. It is still more abundant on the Florida Reefs and throughout the West Indies to Colon, Columbia. A variety occurs at Pernambuco, Brazil. See below, Revised List of Brazilian Corals.

Quelch (op. cit., pp. 181, 182) has recorded two of the forms described by D. and Mich., as from the Cape Verde Islands. But the identity of his forms needs confirmation, by comparison of types. The descriptions and figures of D. and M. are too poor for determination.

I am not at all sure that all the forms described by Duch. and Mich., and referred to this species by Vaughan, are one species, though I have placed them among the synonyms on his authority. If his opinion be correct, then this species is more variable in the Antilles than it is at the Bermudas and Florida reefs, from whence I have examined large series.

There can be no doubt, however, that they have made too many species, by far, in this group. I have seen only two or three forms that could be recognized even as varieties, and doubt if more than two massive species are included in their list, even if all be not forms of *P. astreoides.*

But I believe that Mr. Vaughan is wrong in uniting *P. solida* Ver.=*P. Verrillii* Rehb. to this species. Possibly he has not seen the true *P. Verrillii*, for both species occur on the coast of Brazil.

Porites Verrillii Rehb.

Porites solida Verrill, these Trans., i, part 2, p. 358, 1868.* Rathbun, op. cit., p. 365, 1887, (*non* Forskal, sp., 1775=*P. solida* Klunz., p. 42.)

Porites Verrillii Rehberg, Abh. Naturw. Ver., Hamburg, xii, p. 48, 1892. Vaughan, op. cit., p. 76, 1901.

PLATE XXXI. FIGURE 5.

Mr. Vaughan (op. cit.) considers this only a form of *P. astreoides*, but as the latter occurs with it on the coast of Brazil, he may not have studied a genuine example. I believe they are quite distinct. I have, therefore, figured a portion of the original type.

* The *Porites solida* (Forsk.) Klz., from the Red Sea, is a different, solid, massive species, of which the Yale Museum now has an authentic example. The use of the same name for the Brazilian coral was due to an oversight, on my part, in overlooking Forskal's name,—not to any intention of uniting the two species.

This coral is much heavier and more solid than *P. astreoides.* Its calicles are larger and deeper, and separated by thicker, more prominent, and more solid walls. The details of the calicles are also different, as best shown by enlarged photographic figures.

The 12 septa are well developed and wider than usual. The columella is large, nearly solid, and usually has a central tubercle. Pali are rudimentary or lacking.

That abnormal or imperfectly developed calicles of *P. astreoides* or *P. clavaria* (auth.) may resemble normal calicles of this or other species, is not sufficient proof that they are identical, as Mr. Gregory and Mr. Vaughan seem to think.

If we should use this as a crucial test, then all known species of *Porites* could be reunited into one polymorphic species, for all sorts of variations of this kind can be found in every species of the genus. The same is true of many other genera of corals, e. g. *Madrepora* = *Acropora* V., where the existence of imperfect or unusually formed calicles is a feature found in most of the 200 species.

The only reasonable way to group such corals into true species is to compare calicles that are normally and naturally developed, and those that are fully grown. Starved specimens or calicles, and those that are dwarfed or abnormal from other unfavorable conditions, are very liable to mislead, in this and many other genera, and should not be made too much of.

So the *average size* of *well-developed* calicles is generally characteristic of species, even though the *dwarf* calicles of one might not exceed the average calicles of another. The same rule will apply to all other characters, for all the characters are variable.

According to Mr. R. Rathbun, this species is common on the coast of Brazil, from Parahyba do Norte to the Abrolhos Reefs, and is abundant at Pernambuco. But perhaps part of his specimens were *P. astreoides*, variety. See p. 161. The type was from the Abrolhos Reefs,—coll. C. F. Hartt. No. 4539.

Porites Branneri Rathbun.

Porites Branneri Rath., Catal. Porites, Proc. U. S. Nat. Mus., vol. x, p. 355, pl. xix, fig. 2, 1887. Vaughan, op. cit., p. 77, 1901.

PLATE XXXI. FIGURES 6, 6*a*.

Two Brazilian specimens in the Yale Museum agree well with Mr. Rathbun's description. They are regularly and evenly rounded, very porous masses, formed by a thick encrustation over other species

of dead rounded corals (*Mæandra conferta* in one case), but they show no trace of branching.

The calicles are unusually small and shallow, nearly uniform in size, mostly closely crowded, polygonal, and separated by thin fenestrated walls. The septa are 12 narrow, thin, roughly echinolacerate and fenestrated, often a little exsert; their inner edges unite to a wide columelliform ring, leaving a circle of very small loculi; in the center of the ring-like columella there is a small pit. The pali are very slender, erect, lacerate, mostly 3 to 5, sometimes 6; frequently all are absent or broken off.

The whole surface of the coral has a delicate, lace-like appearance, owing to the uniformly small size of the calicles and the thinness and porosity of the walls.

The masses are 3 to 5 inches in diameter; breadth of the calicles 0.9 to 1.2^{mm}, mostly about 1^{mm}; when in rows there may be 9 to a centimeter.

Parahyba do Norte and Pernambuco, Brazil,—R. Rathbun. Our specimens are from Pernambuco,—coll. C. F. Hartt. No. 4552.

Mr. Vaughan suggested that this might be a young stage of *P. clavaria*. To me they seem to be perfectly distinct.

Family Acroporidæ Ver., nom nov.

Madreporidæ Dana, Zoöph., p. 431, 1846.

Madreporidæ (*pars*) and *Poritidæ* (*pars*) Edw and Haime, Corall., iii, pp 89, 207, 1860.

Madreporidæ Verrill, these Trans, i, p. 501, 1867.

Corals very porous, usually branched or foliaceous, sometimes lobed or massive, encrusting when young, increasing by budding, rarely by fission. Cœnenchyma abundant, porous, often spinulose. Corallites cylindrical, small, generally of two sizes, which may differ in structure. The larger ones may form the terminal or parent calicle of the branches, or occupy only the upper side of foliaceous species.

Calicles small, deep; septa usually 6 or 12; sometimes more in larger sporadic calicles; usually continuous, but perforated. Dissepiments few. Polyps much exsert in expansion; tentacles slender, tapered, generally 12, rarely more.

The genus *Acropora* is the only one in the West Indian fauna, where it has but one species. *Montipora* and *Anacropora* are wholly Indo-Pacific; the former has about 100 species.

Acropora Oken (restr). Type, *A. muricata.*

Madrepora (*pars*) Lam., Syst. Anim., p. 371, 1801 (*non* Linné, ed. x) Lam , Hist. Anim. s. Vert., ii, p. 277, 1816. Dana, Zoöph., p 485, 1846 Edw and Haime, Hist. Corall., iii, p. 132, 1860 (*non* Ehr)

Acropora (*pars*) Oken, Lehr. Naturg., p. 66, 1815 (type, 3d species=A *muricata*)

Heteropora Ehr., Corall Rothen Meeres, p. 333, 1834 (*non* Blainv , a Polyzoan)

Madrepora Rathbun, R., Catal Genus Madrepora in U S Nat Mus., Proc U S. Nat Mus., vol. x, pp. 10–19, 1887 Klunz , Corall Roth Meeres, ii, p. 2, 1879.

Madrepora Brook (with ten subgenera), Cat Mad. Brit. Mus , i, p 22, 1893

Isopora Vaughan, op cit., p. 68, 1901

On pp. 110–113 I have discussed the use of the name *Madrepora*, and its inapplicability to this great genus for which it has so long been used, if we are to follow the strict rules of priority and go back to ed. x of Linné.

The substitute-name that has the prior claim for adoption, and which seems available, is *Acropora* Oken, 1815. This originally included three generic types. The 1st is *Pocillopora damicornis*; 2d is a *Porites*; 3d is *A. muricata* (L.).

The first two having been eliminated by Link and Lamarck, *Acropora* can be restricted to the third species, which is the true West Indian *muricata*.

Vaughan used the much later and objectionable name *Isopora* Studer, 1878, originally applied to a small section of the genus in which the axial corallites are indistinct or clustered. This is so exceptional a character that the group may hereafter be separated as a genus. *Heteropora* Ehr. was preoccupied by Blainville.

The most prominent character of the genus *Acropora* is the existence of a special axial corallite, at the end of each branch, usually larger and more symmetrical than the radial corallites that bud out from its sides and cover the lateral surfaces of the branches.

The latter are various in shape, but are nearly always more or less one-sided and bilabiate; except a few that are to become axial corallites of new branches.

On the under surfaces or on the bases of the branches, or in crowded positions, where the conditions are unfavorable, their prominent margins may be obsolete, or nearly so, or they may be wholly immersed in the cœnenchyma.

The septa are usually in two cycles, those of the second cycle being smaller, and often rudimentary or lacking. In the lateral corallites the directive septa are usually wider than the others.

Acropora muricata (Linné) Oken.

Millepora muricata (pars) Linné, Syst., ed. x, p. 792, 1758.

Madrepora muricata (pars) Pallas, Elench. Zooph., p. 327, 1766. Linné, ed. xii, p. 1279, 1767. Esper (*pars*), Forts., i, p. 58, pl. 50, pl. 51. Lamarck, Syst., p. 371, 1801.

Acropora muricata Oken. op. cit., p. 66, 1815.

Madrepora cervicornis + M. prolifera + M. palmata + M. flabellum Lam., Hist. Anim. s. Vert., pp. 278, 281, 1816. Ditto, Dana, Zoöph. Expl. Exp., 1846. Edw. and Haime, Hist. Corall., iii, pp. 186, 139, 160, 1860. Dana, Coral Islands, ed. iii, pp. 99, 113, 124, 127. (Growth, etc.) Pourtalès, Deep Sea Corals, pp. 83, 84, 1871; Florida Reefs, pl. xvii, pl. xviii, pl. xix, 1880. Gregory, Ann. and Mag. N. Hist., vi, p. 20, 1900.

Madrepora subaquilis and *Madrepora perampla* Horn, Proc. Acad. Nat. Sci Philad., 1860, p 435, (=var. *palmata*, and *alces* auth., types examined)

Madrepora cornuta and *Madrepora Thomasiana* Duch and Mich., op. cit, 1860, p. 82, (=var. *surculo-palmata* and *palmata*)

M. ethica D. and M.. op. cit., p. 82, 1860, but not the figures, (=var. *prolifera*, young or dwarfed).

Madrepora Mexicana Rehb., op. cit., p. 38, pl. iii, fig. 16. 1892.

Madrepora muricata and varieties, Brook, Cat. Mad., i, pp. 23-30, 1893. Vaughan, op. cit, p 69, 1901.

Madrepora palmata Whitfield, Bull. Amer. Mus., x, p. 463, pl xxiv (A very large and fine example.)

PLATE XXXII. FIGURE 1.

The name *muricata* should properly be restricted to this varied West Indian form, as has been done by Brook, Vaughan, and others.

That the five nominal West Indian species: *cervicornis*, *prolifera*, *alces*, *palmata*, and *flabellum*, formerly universally believed to be distinct, are really only variations of one species, must now be admitted, in view of the more careful studies of larger series made during recent years.

This view had been suggested several times, during many years, but Brook was the first modern writer to definitely unite them and consider them all varieties of *muricata*. My own experience had led me to the same conclusion some years ago, for I had seen many intermediate specimens.*

* Gregory, in Ann. and Mag. Nat. Hist., ser. 7, vol. vi, 1900, p. 20–31, dissents from this view, and objects to the use of *muricata* for any American species. The American branched forms were, however, certainly included under *muricata* by Linné, Pallas, Esper, and all other early writers, and Brook had a perfect right to restrict it to the American species. His usage must be followed, according to the ordinary rules of nomenclature.

The most remarkable specimen that I have studied is now figured (pl. xxxii, fig. 1). It is preserved in the Museum of Yale University. In most parts it is a typical specimen of variety *palmata.* But growing out of the upper side of one of its palmate fronds there is a cluster of typical branches of the variety *prolifera.* The two forms are in perfect continuity and there is no evidence of injury or other physical cause for this abrupt alteration in the character of the growth at this particular place. No. 6621.

Many specimens of var. *palmata* have the distal ends of some of the fronds divided into digitate branches of variety *prolifera,* but in such cases the change is gradual. Such subvarieties may be designated as *palmato-prolifera,* for convenience.

Var. *palmata,* when growing vigorously, often produces small, ascending, or incipient branchlets over the whole or part of its upper surface, which is then very uneven. Some of these branchlets sometimes become 75 to 100^{mm} long, and agree with *prolifera.* The large specimen from the Bahamas, in the American Museum, figured by Whitfield (op. cit.) is one of this kind. I have named this subvariety, *surculo-palmata.* *M. cornuta* D. and M. seems to have been based on a specimen of this kind.

Specimens intermediate between variety *cervicornis* and variety *prolifera* are to be found in many American collections, but I have never seen specimens clearly intermediate between *palmata* and *cervicornis,* though such probably exist. They seem to be the extremes of the variations in form.

Variety *flabellum* grows like *palmata,* but forms much thinner fronds than usual.

Many specimens occur, especially in the Bahamas, intermediate between *flabellum* and *prolifera.* In some of these there may be on one side of the same clump, broad frondlike branches of the flabelliform type, while on the other side digitate clusters of *prolifera* may occur; or a flabelliform branch may end in free digitations; or free branches, proximally of the *prolifera* form, may, farther out, coalesce into a flat frond, and distally may again split up into *prolifera* branchlets. The American Museum, New York, has a good series of such intermediate forms, from the Bahamas, (coll. R. P. Whitfield).

For these intermediate forms, I use the name *flabello-prolifera.*

Var. *infundibulum* Ver., var. nov.

This is similar to *palmata*, but it forms broad cup-like or funnel-shaped corals with a nearly even rim, without prominent lobes or digitations. Florida Reefs, Bahamas, etc.

Variety *alces* (auth., ? *non* Dana) = *perampla* Horn, is like *palmata*, but with longer and narrower, thick, digitate fronds.

The name, *M. alces*, was first applied by Dana to specimens said to have been collected in the East Indies by the U. S. Exploring Expedition. I believe that these specimens are still in the U. S. National Museum, where I saw them many years ago, but without careful study. A careful reëxamination of the types would be required to determine whether they be identical with the West Indian form usually called *alces*. Possibly the locality given by Dana was erroneous. But he also gives special differences in the form of the corallites, which he says are tubular and not nariform. Therefore it seems best to use *perampla* for this variety.

Var. *columnaris* Ver., var. nov.

This variety forms large, cylindrical, or long-conical, tapering columns, sometimes 6 to 10 inches in diameter at base, and 4 to 6 feet or more in height, without branches. There is a large conical specimen from Cumana in the Mus. of Comp. Zoölogy.

Varieties *palmata* and *alces* = *perampla* grow to great size. The trunk may become 12 to 18 inches in diameter, with the fronds spreading out to the breadth of 15 to 20 feet, and sometimes attaining a height of 16 to 20 feet or more. The broad, spreading fronds of adjacent trees of this kind may come in contact and partially join themselves together, so as to form large submarine arches. Divers describe the appearance of such growths, when seen from below, as somewhat resembling the trunks and branches of large forest trees. (See also Dana, Corals and Coral Islands, ed. ii, pp. 126, 127, 1874; ed. iii, pp. 126, 127, 1890.)

Var. *cervicornis* also grows to a large size, though much less massive than *palmata*. Tree-like specimens are often 10 feet high and broad, but are difficult to transport. The American Museum has three large ones from the Bahamas. They are about four to five feet high and six feet broad, with the main trunk about three inches (75^{mm}) in diameter. The terminal branches are long and divergent,

round, 35 to 20^{mm} in diameter, regularly and gradually tapered, often curved or even hooked. They grow isolated on a bottom of shell-sand and mud, in 12 to 15 feet of water, near Nassau, N. P.,—coll. R. P. Whitfield.

This species, in its several varieties, is abundant on the Florida Reefs and throughout the West Indies. It is also common as a fossil in the raised reefs of various islands. It does not occur at the Bermudas, nor on the Brazilian coast.

It has been recorded from the East Indies, etc., by Brook and others, but perhaps all such records are erroneous. I have seen no authentic example of either variety from the Indo-Pacific region.

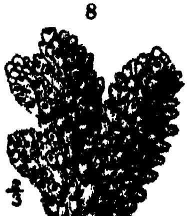
It does not occur at Panama, nor elsewhere on the Pacific coast of America. The *genus* is absent from that coast, except *A. crassa* (E. and H.), recorded from the Galapagos Is.

Gregory (Ann. and Mag. Nat. Hist., 1900, pp. 20–31) gives details of the Indo-Pacific specimens, recorded by Brook, after an examination of the types, and concludes that none of them belong to either of the West Indian varieties, but to distinct species. The Singapore specimen, referred by Brook to *palmata* (No. 93, 4, 7, 24), may be the true *alces* of Dana. According to Gregory, it is distinct from *palmata* in its calicles and cœnenchyma, but grows in the same form.

The *Madrepora ethica* D. and M. (op. cit., p. 82, 1860) seems to be a dwarfed or young, slender form of var. *prolifera*. But the figures referred to it (pl. x, figs. 7, 8) do not agree with the description at all. They appear rather to represent a *Millepora*.

This species, in all its diverse forms of growth, retains pretty constantly the characteristic forms of its axial and radial or lateral calicles, and the characteristic porous and roughly echinulate texture of the cœnenchyma. The radial corallites and their calicles are larger than in most species of the genus. The corallites are rather openly nariform or tubo-nariform, costate, and porous. The septa are well developed, the directives wider. The axial corallites are stout, tubular, usually much exsert, not swollen; walls porous and strongly costate externally; calicles large, tubular; primary septa well developed, subequal; secondaries narrower; the septa form a distinct, 12-rayed star.

8



$\frac{1}{3}$

Fig. 8.—*Acropora muricata*, var. *prolifera*. After Pourtalès, the axial corallites are too small and short.

ERRATA.—Page 51, line 8 from bottom, for Flaggs read Flatts.—Page 128, line 17, for xxxiii, fig. 4, read xxv, fig. 8.

[For explanation of plates, see end of Article IV.]

IV.—Comparisons of the Bermudian, West Indian, and Brazilian Coral Faunæ. By A. E. Verrill.

Plates x–xxxv.

1.—*Characteristics of the Bermudian Coral Fauna.**

The coral-fauna of the Bermudas must be regarded as a detached colony of the more hardy species that have migrated from the West Indies through the agency of the northward currents, by which their free-swimming larvæ have been carried to these islands.

Therefore the particular species that have become established there, have been determined both by the duration of their free larval stages and by their ability to endure the cooler waters of this area.

It has been a process of natural selection, in this sense, though it probably has not yet gone far enough to differentiate a single new species nor even any marked varietal forms.†

Probably most of the species have migrated directly from the Bahamas. How long a time is required for drifting objects to travel from the Bahamas to the Bermudas is not known. The distance is rather more than 700 miles, but any floating object would not travel in a straight line, so that it would, most likely, travel nearly 1,000 miles in such a journey. At the rate of 1 mile per hour the northward drift would be 1008 miles in 42 days, or 720 miles in 30 days. Probably the average rate of the current, in this region, may not be much greater than this.

* After this article was in type I received the important report by Dr. T W Vaughan on The Stony Corals of Porto Rican Waters (Bulletin U. S. Fish Comm for 1900, ii, pp. 289–320, with 38 plates, Dec., 1901). Hence I am able to make use of it only by inserting, in the synonymy, references to it, and especially to the important plates, reproduced from photographs.

But as Mr. Vaughan uses the same nomenclature and repeats the same arguments to sustain his conclusions that he published in his preceding paper of 1901 (Fossil Corals of the Elevated Reefs of Curacoa, etc.), a better opportunity to refer to his work would have involved no changes in my own conclusions.

† Two new species that I have now described from the Bermudas (*Mussa annectens* and *Mussa* (*Isophyllia*) *multiflora* are not yet known from the West Indies, but they will probably be found there when carefully looked for.

But if floating forms should escape from the western Bahamas and pass directly into the full current of the Gulf Stream, where the velocity is three to four miles an hour, a large part of the northward journey could be made in a much shorter time. Then we may suppose that by eastward surface currents, caused by the prevailing southwest winds, such forms could easily be driven eastward from the Gulf Stream to the Bermudas. By this course it is probable that the journey might be made in less than four weeks, under favorable conditions.

That this course is taken by many forms of marine life is certain, for after every period of strong southwesterly winds large numbers of Gulf Stream species of animals are cast ashore on the Bermudas, especially on the southern side. Among these are *Physalia*, the Gulf-Stream crabs and shrimp, etc.

Probably the larval period of many corals is too brief to permit them to make this journey. Others may arrive there that are not able to endure the low temperature of the water during the winter.

Thus it happens that many of the West Indian genera and species are not found at the Bermudas.

The absence of all varieties of *Acropora* (*Madrepora*) *muricata* is particularly noteworthy, for these are among the most abundant and important of the West Indian reef corals.

Other important West Indian genera that are lacking are *Colpophyllia*, *Mœandrina* (= *Pectinia* auth.), *Dendrogyra*, *Dichocœnia*, *Eusmillia*, *Stephanocœnia*, and *Solenastræa*.

The absence of certain very common species of West Indian corals, and the presence of others of the same genera, is also noteworthy. Thus *Mœandra clivosa* and *M.* (*Manicina* auth.) *areolata* are absent, while two other species are present in abundance. *Agaricia agaricites* is absent, while *A. fragilis* is common. *Porites furcata* is unknown, while *P. polymorpha* (= *clavaria*) and *P. astreoides* are common.

On the other hand, some genera and species appear to be more abundant than in most parts of the West Indies. Thus the subgenus *Isophyllia*, so abundant here, seems to be less developed elsewhere. The same is perhaps true of *Oculina* and *Madracis*, as well as of *Agaricia fragilis* and *Mœandra* (*Diploria*) *labyrinthiformis*. The latter is here the prevailing reef coral, but it seems to be relatively less abundant in the West Indies. But Mr. Whitfield informs me that it is very abundant at the Bahamas.

Revised List of Bermudian Corals.

MADREPORARIA.

Family **Mæandridæ.** See p. 65.

Favidæ Vaughan, Stony Corals of Porto Rican Waters, p. 302.

Mæandra labyrinthiformis (L.) Oken. See p. 70.

PLATE X, FIGURES 1–3; PL. XII, FIG. 5.

Common Brain Coral. Brain Stone.

Very abundant on nearly all reefs, except in Harrington Sound.

Mæandra cerebrum (Ellis & Sol.) Ver. See p. 74.

Platygyra viridis Vaughan, op. cit., p. 306, plates ix–xiii.

PLATE X, FIG. 4; PL. XII, FIG. 4; PL. XIV, FIGS. 4, 5; PL. XIX, FIG. 7.

Brain Coral. Brain Stone.

Common on the outer reefs; rare near the shores; absent from Harrington Sound.

Favia fragum (Esper) E. & H. See p. 90.

Favia fragum Vaughan, op. cit., p. 303, pl. viii, figs. 1, 2.

PLATE XIII, FIGURES 1, 2.

Small Star Coral.

Common in shallow water and on the reefs; also in tide-pools.

Family **Orbicellidæ.** See p. 93. Vaughan, p. 300.

Orbicella annularis (E. & Sol.) Dana. See p. 94.

Orbicella acropora Vaughan, op. cit., p. 301, plates vi, vii.

PLATE XV, FIGURES 1, 1*a*.

Star Coral (with small stars).

Outer reefs, not common; rarely on inner reefs. (See figure 9, p. 173.)

Orbicella cavernosa (L.) Ver. See p. 102.

Great Star Coral (with large stars).

Outer reefs, near North Rocks, rare.

Plesiastræa Goodei Ver. See p. 106, cut 1

PLATE XXX, FIGURES 1, 1*a*.

Small-eyed Star Coral.

Outer reefs, at North Rocks, rare; Bailey Bay reefs, rare.

Family **Stylophoridæ.** See p 108

Madracis decactis (Ly) Ver See p 108, cuts 2, 2a

PLATE XIV, FIGURE 6

Ten-rayed Star Coral.

Outer and inner reefs, common; Harrington Sound, 0.5 to 2 fath., not rare.

Family **Oculinidæ.** See p 110

Oculina (Lam., restricted), Dana (*pars*), Edw & Haime.

"Ivory Corals."

The genus *Oculina* is common at the Bermudas, and especially so in Harrington Sound, where it occurs in several forms usually considered as distinct species.

During both my trips to the Bermudas I made large collections of this genus, in order to ascertain, if possible, the number of species and their variations. But I have not as yet had opportunities to devote the requisite amount of time to this subject.

Some of the species of *Oculina* grow at considerable depths. I was told by fishermen that they had occasionally hooked up living branches from 20–25 fathoms, on the hard grounds outside of the outer reefs, but I did not see any of these specimens.

It is certain that all the species are highly variable in general appearance, size of trunk and branches, mode of branching, prominence and size of the calicles, presence and character of the costal striations, amount of cœnenchyma, etc. The number and character of the septa and pali and the size of the columella are also more or less variable. Thus it becomes very difficult to limit the species.

I feel certain that too many species of *Oculina* have been recognized among the Bermuda corals, especially by Quelch, who records seven species. Apparently all my specimens can be arranged in four species, at the most, and perhaps in three. Therefore I now give the following species only provisionally:

Oculina varicosa Lesueur.

Oculina varicosa Les., Mem. Mus. Paris, vi, p. 291, pl. xvii, fig. 19, 1820. Dana, Zoöph. Expl. Exp., p. 67, fig. 28, and p. 394, 1846, type examined. Verrill, Bull. Mus. Comp. Zool., iv, p. 46, 1864. Pourtalès, Reef Corals, p. 66, 1877; Florida Reefs, pl. i, figs. 1-4; pl. ii, figs. 3, 4; pl. iii, figs. 8, 9, 1880. Quelch, op. cit., p. 48, 1886.

PLATE XXXII. FIGURES 2, 3, 4.

Large Ivory Coral. Tree Coral.

This is much the largest and finest species of *Oculina*, as well as the most distinct, but it is comparatively rare, and not often found in very shallow water.

It branches very distantly, in an irregularly arborescent manner, the few branches being usually crooked, rather long, and tapering. The main trunk may be 30 to 50mm in diameter; many of the larger branches are 20 to 25mm in diameter, in large specimens.

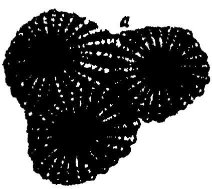


Figure 9 —*Orbicella annularis* D. Group of calicles, somewhat enlarged, after Sonrel. Both figures from Webster's International Dictionary.

Figure 10.—*a*, *Oculina varicosa* Les., tips of two branches with polyps expanded, natural size; *b*, part of a branch, more enlarged, after Sonrel, in Agassiz, Florida Reefs.

The cœnenchyma is abundant, very solid, white, and nearly smooth in the trunk and larger branches, but it becomes small in amount on the tapering terminal branchlets, especially near the tips.

The calicles are mostly of rather large size. The corallites on the principal branches are usually mammiform, with large swollen bases, abruptly narrowing to the cylindrical distal portion, often with the summit and calicle somewhat contracted. But they may vary greatly in the amount of swelling of the base, even on the same specimen. In some cases the bases are very large and much swollen, so as to be nearly hemispherical and in contact proximally. In other cases they are much higher than broad, and subconical, but these may also be in contact proximally. On the under sides of the branches and in other unfavorable places, the calicles may be only slightly raised, and the swollen base may be wanting, or even replaced by a slightly sunken area or fosse, surrounded by a raised border, as in *O. robusta* Pourt. and some of the other species.

On the smaller branches and branchlets the swollen bases of the corallites gradually decrease in size, till they may disappear. In such cases the distal corallites are cylindrical, somewhat prominent, and they stand at a rather wide angle to the branch, even to near the tips. But quite often the bases are distinctly swollen nearly to the tips of the branches.

The costal striæ are often well developed, about 24 in number, radiating on the sides, but often curving at the sutural lines, when the latter are distinct, between the bases of the corallites. On the larger branches and trunk the costal striæ and sutural grooves are often entirely lacking and the whole surface appears smooth.

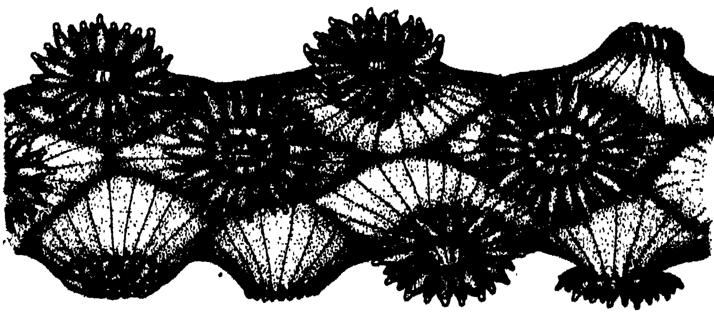


Figure 11.—*Oculina varicosa* Les. Part of a branch with the polyps expanded; much enlarged. From a drawing by A. H. Verrill.

The septa are mostly 24 to 36, varying in width and thickness according to the cycles. The 12 larger ones are usually distinctly thicker and wider than the others, subentire, and only a little exsert, broadly rounded at summit, thick at the walls.

The pali are generally 10 or 12, rather small and thin, and not very prominent. The columella is of moderate size and papillose.

On our largest specimen there are several scattered, abnormally large corallites, having 40 to 56 or more septa. These are exsert and have large and deep calicles with narrow septa. Their calicles are 5 to 7^{mm} in diameter.

The ordinary calicles are mostly about 2·75 to $3{\cdot}50^{mm}$ in diameter, rarely 4^{mm}, but on the thicker branches and trunk their diameter is often only 2^{mm}, being smallest in those corallites that have very swollen bases; these large bases are often 10 to 13^{mm} in diameter and 6 to 8^{mm} high.

Our largest specimen was about 400^{mm} (16 inches) high, when entire.

Bermuda, 6–12 fathoms; in Harrington Sound, etc. Rare on the Florida Reefs and in the West Indies.

Var. conigera Ver., nov.

Oculina varicosa, var , Pourtalès, Florida Reefs, pl. ii, fig. 8, 1880.

PLATE XXX. FIGURE 8.

A remarkable variety, from Bermuda, has large and very prominent conical corallites, sloping continuously from the margin of the calicle to the base, with a smooth, even surface ; no costal striæ. Their bases are in contact and they stand out at nearly right angles to the branch. The calicles are small and contracted, rather shallow, with 24 thin, unequal septa, those of the third cycle being very narrow and thin. Pali small ; columella poorly developed. Only one branch is in the collection. A larger specimen has been well figured in the Report on Florida Reefs.

Oculina diffusa Lam., 1816.

Oculina diffusa Dana, Zoöph., p. 397, 1846. Edw. & Haime (*pars*), Corall., ii, p. 107, 1857 Pourtalès, Reef Corals, p. 65, 1877 ; Florida Reefs, pl. iii, figs. 10–13, 1880 Quelch, op cit , p. 47, 1886, descr.
Oculina diffusa Vaughan, op. cit , p. 294, pl. i, figs. 5, 5*a*, 1901.

Ivory Coral. Bush Coral.

This is the most abundant species, both here and at the Florida Reefs. It usually forms densely branched clumps, with numerous slender ascending branchlets. But it also grows in open, arborescently branched forms. The calicles are rather large, usually 3 to 4^{mm} in diameter. The corallites are more or less prominent, becoming oblique toward the tips of the branches, but on the larger branches they may be surrounded by a depression and outer ridge, or become circumvallate. The septa are usually 24, rather narrow, little exsert. Columella well developed.

Oculina pallens Ehrenberg.

Corall. Rothen Meeres, p. 79, 1834. Dana, Zoöph., p. 67, fig. 29, p 395, 1846, Pourtalès, Reef Corals, p. 66, 1877 ; Florida Reefs, pl. iii, figs. 14–17, 1888 Quelch, op. cit , p. 46, 1886, (descr.).
? *Oculina speciosa* Edw. & Haime, Monog., p. 67, pl. iv, fig. 1, 1850 ; Hist Corall., ii, p. 106, 1857. Quelch, op. cit., p. 50, (descr. and notes on the original type, examined).

Ivory Coral. Tree Coral.

This forms rather handsome arborescently branched corals, about a foot high, with the branches rather few, long, divergent, and tapered. The corallites are of medium size, 2.5 to 3^{mm} in diameter,

rather prominent, somewhat enlarged proximally. They usually stand at a large angle to the branches. The septa are exsert, usually 24; pali are not very well developed; and the columella is rather large and papillose.

It is common in Harrington Sound in 1 to 8 fathoms; Bailey Bay, 2 to 6 fathoms, etc.

Oculina Valenciennesi Edw. & Haime.

Monog. Oculinidæ, p. 69, 1850; Hist. Corall., ii, p. 108, 1857.

? *Oculina Banksi* Edw. & H., Monog., p. 68; Hist. Corall., ii, p. 107, 1857.

? *Oculina Bermudiana* Duch. & Mich., Supl. Corall. Antilles, p. 162 [68], pl. x, figs. 1, 2 (poor), 1866. Quelch, op. cit., p. 51 (as *Bermudensis*).

PLATE XXXII, FIGURE 5.

Ivory Coral. Tree Coral.

This species forms openly and irregularly branched, or rather straggling arborescent corals, a foot or more high, with the branches rather long and crooked. The larger branches are from 12 to 20^{mm} in diameter, in large specimens; corallites mostly circumvallate.

The distal corallites are usually a little prominent, but those on the larger branches and trunk are mostly low, and scarcely exsert; their bases are usually surrounded by a shallow, circular depression, outside of which there is a wide and low surrounding ridge. The depressions and ridges are crossed by the curved, radial costal striations. Common at the Bermudas, especially in Harrington Sound, 1 to 8 fathoms.

The singular looking coral described by Edw. & Haime as *O. Banksii* may be only an older and more developed form of this species, with calicles larger and more deeply sunken in a fosse than usual, and with higher investing ridges. The locality of the type was unknown, but it was from the collection of Sir Joseph Banks.

Catesby (Hist. Carolina, etc., Introduction) states that he made a collection of corals in the Bahamas and afterwards presented them to Sir Joseph Banks, who was one of his patrons. It is probable, therefore, that this type was from the Bahamas.

I have seen a fine specimen, agreeing well with the original description of *Banksii*, in the Amer. Mus. Nat. Hist., from the Bahamas (coll. R. P. Whitfield), but have not had an opportunity to study it carefully.

I can find nothing in the brief description and poor figure of *O. Bermudiana* by which to distinguish it from the present species.

Oculina coronalis Quelch.

Voy. Challenger, xvi, p. 49, pl i, figs 6-6c.

Ivory Coral.

This is an openly branched arborescent species, with the branches long, often divaricate and contorted, spreading in all directions, seldom coalescent.

The most important character is the corona-like, close group of 12 erect, stout pali, which seem to be rather more developed than is usual in any of the other species. The columella is well developed, papillose. Septa 24, unequal, very granulated, little exsert. Calicles distant, 2 to 3^{mm} in diameter.

I have seen no specimens agreeing perfectly with this form, which may be a distinct species. But in most respects it agrees pretty closely with some specimens of *O. pallens*, from which it may not be distinct.

Family **Mussidæ** See p 115.

Mussa Oken, Dana. See pp 115–118, 128.

Mussa + *Symphyllia* + *Isophyllia* + *Mycetophyllia* + ? *Ulophyllia* Edw. & Haime, Hist. Corall, ii, 1857

Cactus Corals.

Since printing the previous article, I have had occasion to study a new species of *Mussa*, described below, which is closely related, in most respects, to the typical species of *Isophyllia*, but yet it has the larger, exsert, distal septal teeth and the distally thickened septa characteristic of *Mussa*. See fig. 12.

In fact, it is truly intermediate between the two groups.

Consequently I am now led to reunite them, together with *Symphyllia*, *Mycetophyllia*, and *Ulophyllia*, in the old genus *Mussa*. But it may, nevertheless, be convenient to keep them in use as subordinate groups, equivalent to sub-genera, or sections, that are not clearly limited by structural characters, such as should characterize true genera.

On pages 115, 116 (note) I have already stated that this would probably have to be done eventually. See also my remarks, below, on the Brazilian species (*M. tenuisepta* and *M. Braziliensis*), which are also connecting species.

It is easy, also, to find in some calicles of typical *Isophylliæ*, like *I. fragilis*, septa that have the distal teeth larger than the rest.

Sometimes this feature, in that species and others, may be found characteristic of many entire calicles. It is then, scarcely more than a variable specific character in some species.

In respect to the *Symphyllia* condition, I will add that I have one specimen of *M.* (*Isophyllia*) *fragilis*, from Bermuda, in which the six calicles terminate entirely distinct dichotomous branches, as in *M. Harttii*, var. *laxa*. The calicles are partly isolated, partly undergoing fission. There is no exotheca.

As to *Ulophyllia*, I am in some doubt, for I have been unable to study more than a few specimens of that group. Other species that have been figured appear to differ more from *Mussa* than those that I have seen, and possibly some of them may be generically distinct.

The Indo-Pacific species of *Mussa* (including *Symphyllia*, typical) differ as a whole from the West Indian species in having broader and more exsert septa, with larger and usually broader distal teeth, and usually in having stronger or more spiniform costal teeth. The columella is also apt to be more lamellose. But all these parts are variable and do not present any tangible generic characters for separating them from the West Indian group. These last present a wide range of variation in the size and character of the calicles and septa, and in their dentition.

Mussa (Symphyllia) annectens Ver., sp. nov.

PLATE XXXV, FIGURES 1, 2.

Rose Coral. Cactus Coral. Tooth Coral (*Bahamas*). *Figure 12.*

Coral massive, either pedicelled or broadly attached, more or less hemispherical, up to 6 inches (150^{mm}) in diameter, with the walls of the corallites united, to their summits, by costæ and cellular exotheca, but nearly always showing a narrow groove along the summit. The proper walls are thin and solid. Calicles of moderate size and deep, mostly in short, separate, lobulate series, with two to four centers. Many of the compound calicles have a stellate or rosette-like form with three to six lobes, each of which has a calicinal center, which surround a larger central one. In other places the calicles run together in sinuous valleys, which are then about 12 to 15^{mm} wide from wall to wall, but between the edges of the septa only 7 to 10^{mm} wide. The largest calicles that are not dividing are usually about 18 to 20^{mm} across, rarely 25^{mm}; depth of calicle to top of wall, 9–12^{mm}. The septa are not very wide, but rather thick distally, and strongly exsert; their summits are often wider than the middle por-

tion, and rounded, but many are narrowed and angular or subacute; all are terminated by two to four, more commonly three, strong, sharp, erect teeth, giving the coral a rough and spinose appearance. The inner edge is usually nearly perpendicular and thinner, and is divided into a variable number, usually six to eight, of sharp spiniform teeth, usually pointing strongly upward. These teeth of the inner edge are generally decidedly smaller, shorter, and thinner than the distal ones, but they are quite variable in size and form, and some of them are sometimes about as large and wide as those of the exsert portion, but not so thick. Sometimes they are all subequal, but in other places they are very unequal. See figure 12.

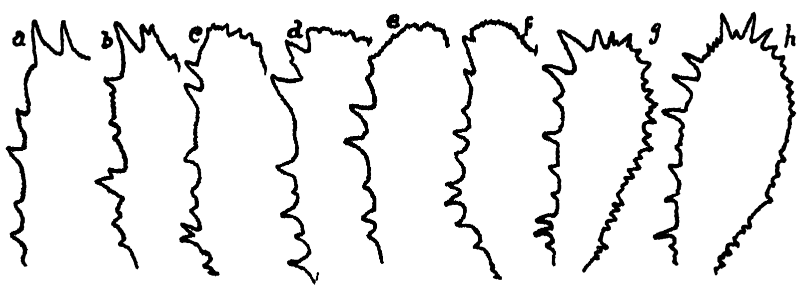


Figure 12.—*Mussa annectens* Ver. A series of outlines of the larger septa, from the type specimen, enlarged; *a*, *b*, two septa with true *Mussa* dentition; *c*, *d*, two septa with dentition of intermediate character; *e*, *f*, two septa of the *Isophyllia* type, *g*, *h*, two septa from the outer side of marginal calicles, to show the character of the costal spines. Drawn by A. H. Verrill.

In the type specimens the septa are rather openly arranged, and separated by interspaces exceeding their own thickness. But in one example they are thicker and more crowded. They are unequal in width and thickness, according to the three or four cycles that they represent, those of the last cycle being almost rudimentary. There are usually seven or eight larger ones to 10^{mm} in the type. The sides of the septa are sharply granulated. The columella is well developed, trabecular, and covered with rough, irregularly divergent spines.

The under side is strongly lobulated near the margin and naked for about 20 to 40^{mm} in the type, but much less in some others. The costæ are rather coarse, irregular, in some places having somewhat raised lamellæ. with sharply serrate edges; in other places low and feebly toothed.

Hamilton Harbor, Bermuda, on the reefs.

This interesting species is represented by three large specimens, 4 to 6 inches in diameter, with numerous calicles. They were recently found in a lot of unassorted corals collected in Hamilton Harbor by Mr. A. Hyatt Verrill, March, 1901, and hitherto overlooked.

It is clearly a true *Mussa*, as contrasted with *Isophyllia*, for the distal, erect, exsert septal teeth are the stronger. The complete union of the walls by exotheca would place it in *Symphyllia*, if that group be recognized.

It is more nearly related to *M.* (*Symphyllia*) *rigida* Dana, of the West Indies, than to any other known species. But it has much larger calicles, and they are compound and much lobulated, and rarely astreiform, as in the latter. The walls, also, are much less solid. It also has a general resemblance to *M.* (*Isophyllia*) *multiflora*, but the latter has thinner and more numerous septa, which are toothed as in *Isophyllia*, and its calicles are smaller and more often isolated.

Mussa (Isophyllia) dipsacea (D.) Ver. See p. 118

PLATE XVIII, FIGS 2, 5, PL. XIX, FIGS 2, 3, PL. XX, FIG 2.

Rose Coral. Cactus Coral.

Occurs in the same places as the following; common.

Mussa (Isophyllia) fragilis (D.) Ver. See p. 121.

PLATE XVI, FIGS. 1, 2, PL. XVII, FIGS. 1–7; PL. XVIII, FIGS 1, 6, PL. XIX, FIGS 1, 4, 5.

Rose Coral. Cactus Coral.

Outer and inner reefs and rocks, and on shallow flats, very common; Harrington Sd., common in 2–8 feet of water.

Mussa (Isophyllia) multiflora Ver. See p. 125

PLATE XX, FIG. 1; PL. XXV, FIG. 1.

Outer reefs; Serpuline atolls; Hamilton Harbor, not common.

The numerous other species of *Isophyllia* and *Lithophyllia*, recorded by Quelch, are probably all varieties and young of *M. fragilis* and *M. dipsacea*.

Family **Agaricidæ**. See p. 139.

Agaricia fragilis Dana. See p. 142.

PLATE XXVI, FIGURES 1*a*–1*d*.

Hat Coral. Shade Coral.

Bermudas, on the reefs in shallow water; Castle Harbor; Harrington Sound, 0.5 to 3 fathoms, common; Florida and the West Indies, rather rare.

Siderastræa radians (Pallas) Ver. See p. 158.

Vaughan, Corals Porto Rican Waters, p. 309, pl. xv, pl. xvi, fig. 2, 1901.

PLATE XXX, FIGURE 1.

Star Coral.

Bermudas, common, both on the reefs and in shallow water in all bays and sounds; grassy flats of Long Bird Island at low tide and in pools, etc. Florida; everywhere in the West Indies and to Colon; abundant.

Siderastræa siderea (Ellis & Sol.) Blainv. See p. 151.

Vaughan, op. cit., p. 309, pl. xiv, figs. 1, 2, pl. xvi, fig. 1, 1901.

PLATE XXX, FIGURES 2, 3

Star Coral.

Bermudas, much less common than the last. Florida Reefs and West Indies; Colon, etc.; common.

Family **Poritidæ** Gray, 1840 Dana, 1846. See p. 158.

Porites polymorpha Link. See p. 158.

Porites porites (*pars*=forma *clavaria*) Vaughan, op. cit, pp. 314–316, pl xxix, pl. xxxi, fig. 2.

PLATE XXXI, FIGURES 3, 3*a*.

Bermudas, common on the reefs and also in the shallow bays, 0.5 to 3 fathoms; Harrington Sound. Florida and through the West Indies; abundant.

Porites astreoides Les. See p. 160.

Porites astreoides Vaughan, op. cit., p. 317, plates xxxii–xxxiv, 1901.

PLATE XXXI, FIGURES 4, 4*a*.

Common in shallow water and on the reefs, 0.5 to 4 fathoms. Florida and through the West Indies to Pernambuco, Brazil, abundant.

HYDROCORALLIA.

Family **Milleporidæ** Flem (*pars*), 1828. Edw. and Haime (*pars*), Hist Corall, iii, p 224, 1860.

Millepora alcicornis Linné

Dana, Zoöph., p. 548, 1846 Edw & Haime, Corall, iii, p 228, 1860. Pourtalès, Florida Reefs, pl xx, figs 1–6, 1880, excellent Quelch, Voy. Chall, xvi, p 190, 1886 Vaughan, Corals Porto Rican Waters, p 318, plates xxxv–xxxviii

Finger Coral. Sea Ginger. Ginger Coral.

Figure 18 —*Millepora alcicornis* L
Tips of branches, $\frac{2}{3}$ natural size After Sonrel, in Agassiz.

Abundant everywhere on the Bermuda reefs and also on ledges and rocks near the shore, in 0·5 to 5 fathoms; Harrington Sound, 0.5 to 4 fathoms. Abundant on the Florida Reefs and throughout the West Indies to Colon. Abrolhos Reefs, Brazil, (var.)

Quelch recorded also *M. ramosa* Pallas (two specimens), and *M. Carthaginiensis* Duch. & Mich., as from the Bermudas. I did not find any specimens agreeing with either of these forms, which may be only growth-varieties of *alcicornis*.

The following species, which are not reef-corals, were recorded by Moseley as dredged by the Challenger about the Bermudas. See vol. ii, part 7, pp. 138–184, 1880:

? *Caryophyllia cylindracea* Reuss.; Moseley, p. 138.—435 fath.

Axohelia dumetosa Duch.; Moseley, p. 182.—435 fath.

Cladocora arbuscula Edw. & H.; Moseley, p. 184.—435 fath.

Bathyactis symmetrica Moseley, p. 186, pl. xi, figs. 8–9*a*.—32 fath. and 1075 fath.

Deltocyathus italicus Edw. & Haime; Moseley, p. 145, cuts.—1075 fath.

Caryophyllia communis Moseley, p. 135, pl. i, figs. 4–5*a*.—690 fath.

Madracis asperula Edw. & Haime ; Moseley, p. 182.—On Southwest Bank, 30 fath. See p. 109, above.

Mr. G. Browne Goode, in a letter in 1877, mentions finding a small *Astrangia* at the Bermudas. The specimens have not been found in his collections. It may have been *Astrangia solitaria* (Les.) Ver., which is common in the West Indies.

2.—*Characteristics of the West Indian Coral Fauna.*

The coral fauna of the West Indian area is remarkably uniform from Florida and the Bahamas to the Lesser Antilles and the coast of Venezuela, and to Colon. The Florida reefs and keys, so far as known, lack a few species that are found in the Bahamas and further southward. But this may be due to the much greater difficulty in making collections on the outer reefs of Florida, as compared with those of the Bahamas. Still the list of Florida reef-corals published by Pourtalès (Mem. Mus. Comp. Zoöl., ii) includes nearly all the important West Indian species, though some that are abundant elsewhere seem to be rare on the Florida Reefs. Among the larger Bahama species, not yet known from Florida, are *Dendrogyra cylindrus*, *Stephanocœnia intersepta*, *Solenastræa hyades*, *Plesiastræa Goodei*, *Mussa rigida*, *Agaricia crassa*. But it is probable that all these will eventually be discovered there.

The lists of species known from Colon and Cumana are probably very imperfect, as they represent only a small amount of collecting, but they include most of the ordinary West Indian reef-corals.

At Curacoa the coral fauna is known to be essentially the same as in the Bahamas. The same is true of St. Thomas and Guadaloupe.

The West Indian coral fauna is, however, totally distinct from that of Panama and the Indo-Pacific region. Not a single species is positively known to be common to the West Indies and either of those regions.*

With the coral fauna of Brazil there is a direct relationship Apparently a few of the species are also closely related to, and perhaps identical with, those of the eastern Atlantic.*

* Quelch (Voy. Challenger, xvi, pp 91, 99) records *Manicina areolata* from 10–20 fath., off Cape of Good Hope, and *Favia fragum* from the Azores, on the shores. He also records (pp. 181, 182) from the Cape Verde Islands, two of the nominal West Indian forms of *Porites* described by Duch. & Mich , but the latter are absolutely indeterminable without comparison of the types. His species may be quite different.

This is not surprising, for various West Indian mollusks and echinoderms, and some gorgonians, etc., are known to occur on the E. African coasts.

With the Mediterranean fauna there is little resemblance, but the genus *Cladocora* is found in both faunæ.

The West Indian coral-fauna is characterized by a few genera that are not known to occur in the Indo-Pacific fauna, and by others that are comparatively rare in that fauna. But there is no *family* of corals restricted to the West Indies.

Among the genera peculiar to the West Indies are *Colpophyllia*, *Dendrogyra*, *Meandrina*, rest. (= *Pectinia* auth.), *Eusmillia*, *Stephanocœnia*, and perhaps the subgenus *Isophyllia.*

Among the common genera that are comparatively rare in the Indo-Pacific, the following may be mentioned: *Agaricia*, *Siderastræa*, *Cladocora*, *Madracis*, *Oculina* (rest), *Dichocœnia*, *Orbicella*

But the West Indian reef-fauna is also characterized by the conspicuous absence of a large number of genera and even of some large *families* of corals that are abundant in the Indo-Pacific.

Among the families that are lacking are the *Turbinaridæ*, *Eupsammidæ*, *Fungidæ** (with numerous genera), *Pocilloporidæ.*

Of the important Indo-Pacific *genera* that are lacking, the following are notable: *Turbinaria*, *Astræopora*, *Montipora*, *Alveopora*,† *Synaræa*, *Psammocora*, *Pavonia*, *Pachyseris*, *Fungia*, *Herpetolitha*, *Cryptobacia*, *Halomitra*, *Podobacia*, *Merulina*, *Hydnophora*, *Tridacophyllia*, *Echinopora*, *Mycedium* (restr.), *Ulophyllia*, *Trachyphyllia*, *Galaxea*, *Euphyllia*, *Plerogyra*, *Favites* = *Prionastræa*, *Acanthastræa*, *Pocillopora*, *Stylophora* (true), *Seriatopora*, and many others.

The total absence of the slender-branched, corymbose and cæspitose species of *Acropora* (*Madrepora* auth.) is one of the most conspicuous differences between the West Indian and the Indo-Pacific reefs. Such species are exceedingly abundant and varied on the latter, and give to them some of their most striking characteristics. The absence of *Pocillopora*, which abounds on all the Indo-Pacific reefs, and even in the Panama fauna, is also a striking feature of the West Indian reefs. There are, however, a number of genera that are well developed and abundant in both of these great faunal areas. Among these are *Porites*, *Mæandra*, *Favia*, *Solenastræa*, *Mussa*, *Millipora*, and the stout-branched species of *Acropora.*

* A few small, simple representatives of this family, from *deep water*, have been described by Pourtalès.

† Species of *Alveopora* have been described as fossils in the later tertiary deposits of some of the islands, but none are known living in the West Indies.

The interesting relations between the West Indian and the Brazilian coral faunæ will be discussed in the next chapter.

At present, it is impossible to make a satisfactory general catalogue of the West Indian corals. This is due mainly to the large number of forms badly determined and too imperfectly described by Duch. and Michelotti, especially those of the genera *Mussa* (*Isophyllia*), *Agaricia*, *Porites*, etc. All of these and others need careful revision, with large collections and comparisons of types

3.—*Characteristics of the Brazilian Coral Fauna.*

The known Brazilian reef corals are but few in number, though the reefs have now been well explored, but they are of unusual interest, partly because they constitute a very special coral fauna, and partly because several of them present remarkably generalized or archaic characters, combining within a single species characters which ordinarily characterize two or more distinct genera.

This would seem to indicate that this fauna is a small surviving remnant of an ancient coral fauna that has mostly disappeared. Possibly this fauna may date back to the early Tertiary period. Certain of the still existing species may have been the ancestral species from which some of the modern West Indian reef-corals may have been derived, by evolution, under more tropical conditions.

Among those of special interest in this way, I may mention, especially, *Mussa Braziliensis* and *M. tenuisepta*, both of which present characters of *Mussa* (group *Symphyllia*), *Isophyllia*, and *Favia*, so that they might be placed about equally well in either of these three groups, while they also closely resemble *Acanthastræa*.

Mussa Harttii occurs in the form of a typical *Mussa*, with free dichotomous branches, and in the form of a *Symphyllia*, with abundant exotheca, uniting the corallites completely together. But all sorts of intermediate states also occur. Thus it serves to compel the union of these genera.

Mæandra conferta Ver., originally referred by me to *Favia*, is almost exactly intermediate between the two genera in all its characters, and therefore shows their close relations and common origin.

It is specifically allied to *F. gravida*, which lives with it, and also to *F. fragum* and *Mæandra Agassizii*, as well as *M. clivosa*, of the West Indies. Indeed these five species form a nearly continuous series of closely related forms, ranging from typical *Favia* to typical *Mæandra*.

On the other hand, *Favia leptophylla* Ver. closely resembles an *Orbicella*, and especially the Brazilian *Orbicella aperta* Ver., not only in external form and appearance, but especially in the internal structure, both of the endotheca and exotheca (see the figured sections, Plates xiii and xxxiii, from photographs). Indeed, they are so much alike that I have, at times, hesitated to keep them apart, even as separate species.

And yet the former increases mainly by median or submedian fission, as in *Favia*, while the latter increases mainly by extramural or exothecal budding, as in typical *Orbicella*. In *O. aperta*, however, fission occasionally occurs, while a few exothecal buds can be found on *Favia leptophylla*.

Thus these two forms serve to show the close relationship of two genera, which are typical of two groups, often considered as of subfamily or even family rank. I very much regret that I have been unable to study a large series of these forms, for such a series might even compel us to unite the two in one species, which might then be referred to either genus, about equally well.

Siderastræa stellata is, in several ways, intermediate between *S radians* and *S. siderea*, the two West Indian species, though perhaps nearer to the former. It may well have been the ancestral form of both.

Meandrina (*Pectinia*) *Braziliensis* must be considered as a primitive or ancestral form of its genus, for it retains through life the simple lobulated condition of growth characteristic of the young of the much larger and more complex forms (*M. meandrites*, etc.) found in the West Indies.

The Brazilian *Agaricia*, so far as known, resembles the young of the West Indian *A. agaricites* much more than the adult.

Very few of the Brazilian reef corals are strictly identical with those of the West Indies. This is due, undoubtedly, to the vast volume of fresh water discharged by the Amazon River. This forms a barrier absolutely impassable to many forms of shallow-water marine animals, and to their free-swimming larval stages, when these live at the surface or at moderate depths. Those species living at the bottom, at considerable depths, would be less affected, for the fresh water would reach the bottom only at moderate depths, and near the coast.

But as the reef corals are all sensitive to brackish water, and all inhabit shallow water and have free-swimming, surface-dwelling larvæ, they naturally form one of the groups least able to pass such

a barrier as is produced by the Amazonian waters. Indeed, the wonder is that any of the species should ever have passed this barrier, except by human agency, unless they were in existence at a time when the South American continent was less elevated, and when the lower Amazonian valley may have been a great salt-water Bay.*

It is possible, of course, that some of the smaller and rarer incrusting forms, like the *Agaricia*, may have been carried from the West Indies to Brazil on the bottoms of vessels. If such vessels were kept well out at sea, away from the Amazonian waters, this might occur, for I have seen fine branching specimens of *Oculina*, six inches in height, as well as other corals, taken from the bottoms of vessels at the Bermudas. But the abundant and larger species, widely distributed on the coast, cannot be accounted for in any such way. In fact, the only ones to which such an explanation could possibly be supposed to apply, would be the *Agaricia*, *Porites astreoides*, var., and *Millepora alcicornis*. But the two latter are too abundant and too widely distributed to make such an explanation seem reasonable.

Since the course of the ocean currents along that coast is northward, any species common to the two faunæ is far more likely to have been carried northwards from Brazil to the West Indies by their agency, than in the opposite direction. Indeed, it would seem impossible for such species to migrate southward along the northern Brazilian coast.

Therefore the original home of those species found in both regions must have been the Brazilian coast.

Most of the Brazilian corals were first described by me in vol. i, part ii, of these Transactions, 1867, but they were not then figured. Prof. C. F. Hartt contributed to that paper notes on their habits and distribution.

The structure, extent, and distribution of the Brazilian coral reefs have been described by Prof. C. F. Hartt† and by Mr. R. Rathbun.‡ Prof. J. D. Dana, in his "Corals and Coral Islands," has made extracts from Prof. Hartt's descriptions (see pp. 140–142, and p. 55 of ed. iv, 1890), and on p. 118 has given a partial list of the corals.

* It has even been suggested that a direct marine connection between the Atlantic and Pacific Océans, by the way of the Amazon Valley, may have existed in the Cretaceous and early Tertiary periods.

† Geology and Physical Geography of Brazil, 1870, pp. 187–214.

‡ Notes on the Coral Reefs of the Island of Itaparica, Bahia, and of Parahyba do Norte, Proc. Bost. Soc. Nat. Hist., xx, pp. 39–41, 1878; Brazilian Corals and Coral Reefs, Amer. Naturalist, xiii, pp. 539–551, 1879.

Many of the important West Indian genera of reef-corals are apparently absent from the Brazilian reefs. Among these are *Acropora* (*Madrepora* Lam.), *Colpophyllia*, *Dendrogyra*. *Dichocœnia*, *Solenastræa*, *Oculina*, subgenus *Isophyllia*, etc

The absence of large species of brain corals (*Mæandra* = *Meandrina* and *Diploria* auth) is also a remarkable feature, for these and the several varieties of *Acropora muricata* are the most conspicuous and most abundant of the West Indian corals, and contribute more than any others to the growth of the reefs

The Brazilian coral fauna is, however, far more nearly related to the West Indian fauna than to any other. It has no special connection with the Indo-Pacific fauna, nor with the Panamaian fauna. The only genera found common to Brazil and the Indo-Pacific region are the nearly cosmotropical genera, *Porites*, *Favia*, *Mussa*, *Orbicella*, and *Millepora*. Of these, *Porites* alone occurs at Panama But the species, even of these genera, are allied to the corresponding West Indian forms, and less so to those of the Indo-Pacific.

On the other hand, none of the characteristic Indo-Pacific genera and species occur on the Brazilian reefs. (See above, p 184.)

Revised List of Brazilian Reef Corals

MADREPORARIA.

Family **Mæandridæ** Ver See p 65

Mæandra conferta Ver See p 84, and these Trans , i, p 355

PLATE XIII, FIGURE 6

Abrolhos Reefs, types, (C. F. Hartt); Bahia and Fernando Noronha (Hartt); Mar Grande, Bahia (Rathbun); Pernambuco (Hartt, Rathbun). Cape Frio to Pernambuco, common in tide-pools (Hartt).

Favia gravida Ver See p 91, and these Trans , i, p. 354

PLATE XIII, FIGURE 3

Abrolhos Reefs, type, (C. F. Hartt); Pernambuco and Bahia (R. Rathbun); Cape Frio to Pernambuco, common in tide-pools (C. F. Hartt).

Favia leptophylla Ver. See p. 91, and these Trans., i, p. 358.

PLATE XIII, FIGURES 4, 5.

Abrolhos Reefs, type, (C. F. Hartt).

Family **Orbicellidæ.** See p. 98. Vaughan, p 300.

Orbicella aperta Ver. See p. 103, and these Trans., i, p. 356.

PLATE XXXIII, FIGURES 1, 1*a*.

Abrolhos Reefs, type, (C. F. Hartt); Itaparica, Bay of Bahia (C. F. Hartt, R. Rathbun).

Orbicella Braziliana Ver See p 101

Off Barra Grande, in 30 fathoms, Challenger Exped. (Quelch).

Orbicella cavernosa, var **hirta** Ver See p. 103.

PLATE XXXIII, FIGURE 2, 2*a*.

This form, briefly described on p. 103, deserves further notice. Although it resembles *O. cavernosa* in appearance, it differs so much in details that it may hereafter be separated as a distinct species, when a series of specimens can be carefully compared. I have, unfortunately, only seen one specimen. This is an incrusting plate, 130^{mm} broad and 30 to 40^{mm} thick.

The mature corallites are pretty uniform in size, rather exsert, near together, nearly round, roughened by the slightly exsert, unequal, rudely serrulate, rounded tops of the septa, and strongly costate on the nearly vertical sides. The costæ are rather elevated, unequal in height, but nearly equal in thickness, not much thickened above, interlocking; their edges are roughly and lacerately serrulate, or hispid, the teeth being divided into small points; their sides are also roughly hispid with sharp granules, leaving narrow intercostal spaces. The calicles are wide and deep. The septa are about 40 to 48 in the larger calicles, those of the last cycle being quite narrow, but nearly as high as the others distally, and toothed in the same way. The 24 larger septa are subequal, rather narrow, rounded distally, their inner edge concave or perpendicular, so that the calicle is broad below, and often slight constricted above by the overarching of the upper part of the septa. The entire edge of the septa is roughly serrulate, but more so on the distal portion, and their surfaces are roughly granulated. At the base there is a rough, spine-like paliform tooth, directed inward to the columella, and often

blending with the processes of the latter. The columella is broad, flat, rudely trabecular, covered with rough, blunt, papilliform spines.

In sections, the exotheca is very cellular with several rows of arched dissepiments; the walls are thin and compact; the endotheca is formed by wide, thin, sloping dissepiments; septa trabecular and perforated near the columella.

Diameter of the larger calicles, 7 to 8^{mm}; depth, $2\text{–}3^{mm}$.

Bahia, Brazil, R. Rathbun, 1876.

Orbicella cavernosa, var. compacta (Rath MSS), Vaughan.

Vaughan, op. cit , p. 81, 1901

According to Mr. Vaughan, Mr. Rathbun had considered this a distinct species, but Mr. Vaughan, himself, thinks it only a variety of *O. cavernosa*, "with dense walls between the corallites." I have not seen the specimens.

Figure 14.—*Meandrina Brasiliensis.* A young specimen, No 4557. Natural size.

Family **Eusmillidæ** Ver. See p. 118.

Meandrina Lam., 1801, *non* 1816. See p. 66.

Meandrina Brasiliensis (Edw. & Haime) Vaughan.

Ctenophyllia Brasiliensis Edw. & Haime, Monog., Ann Sci. Nat., x, p. 279, pl. vi, fig. 7, 1849.

Pectinia Brasiliensis Edw. & Haime, Pol. foss. palæoz., p. 57, 1851; Hist. Corall., ii, p 209, 1858. Verrill, these Trans., i, p. 358, 1867.

Meandrina Brasiliensis Vaughan, op. cit., p. 20, 1901.

Plate xxxiv, figure 1.

This elegant species is pedicellate and usually oblong in form, with the secondary collines and valleys mostly transverse and simple. (See p. 186.) The valleys are deep; the septa are wide, rounded distally, exsert, and nearly entire.

According to Mr. R. Rathbun (op. cit., p. 542), it usually does not occur attached to the reefs, but on the mud-flats, in sheltered places, partially buried in the mud, and usually unattached when mature (at Bahia, etc.). But when young it is, even in such places, undoubtedly attached to small pieces of stone, or shells, as is the case with other similar corals (*Mœandra areolata*, etc.).

A young specimen from the Abrolhos Reefs, in the Yale Museum (No. 4537, coll. C. F. Hartt), was, however, firmly attached by a pedicel 23mm long and 16mm wide, and somewhat expanded at the edge of the attached base.*

This specimen (fig. 14, above) is 52mm long, 33mm wide, 32mm high. The valleys are mostly 7 to 9mm wide; the collines (and septa) are about 8 to 9mm across, where simple.

Thus all the calicinal centers and grooves and their septa are much smaller and narrower than in the adult, which is in accordance with all young meandriform corals.

Its margins are deeply lobulated, with four lobes on one side and five on the other. The infoldings that form the collines are deep; three of the collines on each side have already subdivided distally into two or three short lobes, defining short valleys that start out from the median valley, which is as narrow as the lateral ones.

The septa are rather thin, alternately wider and very narrow, but the wider ones are alternately unequal, as if in three cycles. The larger ones are broadly rounded distally, little exsert, nearly perpendicular within the valleys. The distal third of their edges is

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* In contrast with this specimen, I add a description of a young example of *M. meandrites*, of almost exactly the same size, from the Bahamas, collected by R. P. Whitfield, and now in the Amer. Mus. Nat. History. It was firmly attached by the central part of the base.

Length, 50mm; breadth, about 18mm; height, about 35mm. It has six primary marginal folds or lobes, and about three small secondary ones, some just forming, and a little irregular.

The septa are somewhat exsert, entire, or nearly so; the edge is convexly rounded and narrowed distally. Small narrow ones alternate with the wider ones. Columella large, formed of small convoluted lamellæ and trabeculæ, without any median continuous lamella. Collines narrow, double in most parts.

External wall with raised, unequal costæ, two or three small ones between the larger ones, and sparsely serrulate with small, rough denticles.

"Color of the animal, in life, emerald green" (Whitfield).

Another young specimen, from the same collection (No. 507), is a little larger. Length, 75mm; breadth, 62mm; thickness, 36mm. This is already meandriform, with deep valleys and stouter collines. The columella is small, but coarsely lamellose, with irregular thickenings, but without a median lamella.

minutely and sharply serrulate, each denticle forming the end of a curved series of sharp granules on each side. These gradually fade out proximally.

The columella is formed by a continuous, median, lamelliform plate, and by thin, interrupted lamellæ on each side of it, formed by foliate extensions of the lower inner edge of the septa, which bend to one side and unite together more or less, and also join the central lamella at irregular intervals.

The exterior wall is covered with rows of small, rough, or lacerate, conical spinules that stand on slightly raised costæ. There is no epitheca. The exterior was covered with living tissue to the basal edge of the pedicel. The larger specimen, figured on plate xxxiv, fig. 1, was from Itaparica I., Bay of Bahia. No. 4543.

Abrolhos Reefs and Victoria (Hartt); Itaparica I., Bahia (Rathbun).

Family **Mussidæ** Ver. See p 115.

Mussa Harttii Ver. See p. 128, and these Trans., i, pp. 357, 358, 1867.

PLATES XXII, XXIII, XXV, XXXIII.

Var. **laxa**, Ver. See p. 128.

PLATE XXIII, FIGURE 2.

Abrolhos Reefs, type, Victoria, Porto Seguro, and Pernambuco (Hartt); Bahia (R. Rathbun). Mostly in 3–6 feet of water (Hartt).

Var. **conferta** Ver. See p. 129.

PLATE XXIII, FIG. 1; PL. XXV, FIG. 8; PL. XXXIII, FIG. 3.

Abrolhos Reefs, type, (C. F. Hartt); Pernambuco, Victoria, Porto Seguro, Mar Grande, and Periperi, Bahia (C. F. Hartt, R. Rathbun).

Var. **intermedia** Ver. See p. 128.

PLATE XXII, FIGURE 2.

Pernambuco (Rathbun).

Var. **confertifolia** Ver. See p. 129.

PLATE XXII, FIGURE 1.

Pernambuco, type, (Derby and Wilmot), No. 4551.

Mussa (Symphyllia) Brasiliensis Ver.

Acanthastræa Brasiliensis Verrill, these Trans., i, p. 355, 1867.

PLATE XXI, FIG. 1; PL. XXXIII, FIG. 4.

This cannot properly be retained in *Acanthastræa*, for it increases by median and submedian fission. The calicles are very irregular, varying from circular to oblong-elliptical, hour-glass shaped, three-lobed to five-lobed, etc. They often have three or more centers. They are also very variable in size. Where the calicles are crowded the walls are completely united, thin and solid ; in some other places they are united by cellular exotheca and costæ.

The mode of growth and forms of the calicles are like several species of *Mussa*, especially *M. hispida* V. and *M. rigida* D., to which it is evidently closely allied. From the former it differs chiefly in the smaller size of the calicles, the reduced columella, the fewer and less laciniate septa, and the thinner walls, solid or with little exotheca.

But the larger and somewhat paliform teeth at the base of the septa cause it to resemble some species of *Favia*, very decidedly. It might, in fact, be referred to that genus without hesitation by some writers, for it is in several ways an intermediate species. But it seems to lack true paliform lobes or teeth. It appears to be related more directly to *Mussa tenuisepta* V. and *M. Harttii*, which inhabit the same region. It may, then, be considered a *Favia*-like *Mussa*, with unusually small and well isolated calicles for a *Mussa*.

Abrolhos Reefs, type, No. 1467, Porto Seguro, Sta. Cruz, Bahia ; Maceio, low tide to 15 feet or more, abundant (C. F. Hartt).

Mussa (Symphyllia) tenuisepta Ver , sp nov. See p 127

PLATE XXI, FIGURE 3.

Coral massive, astreiform, with the corallites mostly isolated and united to the edges of the calicles by costæ and cellular exotheca, the division walls usually showing a superficial furrow at the surface Proper calicinal walls very thin. Under side closely adherent to very near the edge in the types ; the exterior costæ, where visible, are thin, elevated, and lacerately spinulose.

Calicles moderately large, diameter mostly 15 to 25^{mm}, average about 20^{mm}, rather shallow, rapidly narrowed to the bottom, irregular in form. Many of the smaller ones are rounded, but the larger ones are mostly lobulate, with two to four lobes, and many are undergoing median or submedian fission. A few small calicles seem to have arisen from exothecal buds.

The septa are thin, numerous, rather crowded, not very wide, little exsert, with their thin inner edges sloping and deeply laciniately

toothed; lateral surfaces sharply and finely spinulose The teeth are often of nearly uniform size and length on the whole edge, but more frequently the upper ones are wider and thicker, while the lower ones are slender, sharp, mostly branched, thorny or lacerate, but often acute and simple. Very thin and narrow septa often alternate with the wider ones. Columella well developed, trabecular and roughly spinulose

The larger specimen is about 112^{mm} broad and 45^{mm} thick.

Pernambuco, 1870, two types (C F. Hartt), Nos. 4542 and 4543.

This species might be placed in the subgenus *Isophyllia* about as well as in *Symphyllia*, for in the smaller specimen the distal teeth are generally not larger than the proximal But in the larger example the reverse is true, so that it is another intermediate form.

It is nearly allied to *M. hispida* V. (see p. 127), but has more numerous and thinner septa. A larger series may eventually show that they are varieties of a single species

Family **Astrangidæ** Ver These Trans , i, p 524, 1867

Astrangia, sp

Mr. R. Rathbun (op. cit., 1877, p. 542) mentioned the occurrence of an *Astrangia* on the Brazilian reefs, but I have not seen the specimens referred to. He stated that the corallites are widely separated, but "united by thin, creeping stolons."

According to Vaughan (Porto Rican Corals, p. 299), there are three species of *Astragidæ* on the Brazilian coast · An *Astrangia* similar to *A. solitaria* (Les.) Ver., 1864; a new species, *A. Rathbuni* Vaughan, MSS.; and *Phyllangia Americana* Edw. and Haime.

Family **Agaricidæ** Ver See p 189

Agaricia agaricites (Linné) E & Haime. See pp 146, 149.

PLATE XXVI, FIG 2, PL XXVII, FIGS 2, 2*a*, 7, 7*a* (typical form)

Var. **humilis** Ver., nov

Agaricia agaricites? Verrill, these Trans , i, p 352, 1867

Coral small, encrusting, but often with a narrow, very thin, translucent free edge, which is delicately striate-costulate externally, the costulæ being alternately larger and smaller and minutely granulated.

Calicles small, deep, crowded, mostly in short, irregular, concentric or sinuous series of 3 to 12, in narrow, deep valleys, separated by narrow, acute collines, which often anastomose. In the young speci-

mens, 15 to 30^{mm} broad, the collines are less acute and pretty regularly concentric around a larger, regular, central, primary calicle.

The septa are mostly in three cycles, and of three different sizes; the number varies from 20 to 32. The primary and secondary septa are thickened, especially distally, but the primaries are wider and thicker proximally than the others; tertiaries are much narrower and thinner; all are finely and sharply granulated laterally, and a little exsert. They are not so much crowded as in typical *agaricites*, and are more unequal in size and thickness. The central pit is deep and narrow. Columella is small, solid, umbonate.

Diameter of ordinary calicles 1.5 to 2.5^{mm}; of central one, about 4^{mm}.

According to Prof. Hartt it never becomes more than two or three inches broad. Our largest specimen is 65^{mm} broad, partially covering a rather thickish frond of partially dead coral of the same kind, which appears to have been repeatedly nearly killed and then renewed by outgrowths. It shows no tendency to form upright crests or fronds, but one edge is free for a breadth of 30^{mm}, but of this only 4 to 6^{mm} was living.

The other specimens are young. The smallest is a simple primary corallite, 4^{mm} in diameter, closely sessile, even to the edges; it has four cycles of unequal septa. The next larger (on the same *Mussa*) is 15^{mm} broad, with a larger primary central calicle and two concentric circles around it, with some of the third circle on one side. This is also closely adherent and incrusting to the very edge, except at one place, where the edge is free for 2 to 3^{mm}. In this the inequality in thickness of the cycles of septa is very marked.

This form may prove to be a distinct species when a larger series can be studied, but with my small specimens the distinctive characters seem very slight, and may be largely due to immaturity, or to a dwarfed state, owing to unfavorable conditions of growth.

It agrees better with a young specimen from Key West, Florida (pl. xxvii, figs. 2, 2*a*, No. 103), than with any of the other West Indian forms that I have. But the latter has larger calicles; much higher and larger collines; thicker, closer, and less unequal septa; more finely and evenly striated exterior; and a less closely incrusting mode of growth. I have considered the latter a young stage of the typical *agaricites*.

The var. *pusilla*, from Colon, has decidedly smaller calicles and collines, and appears more like a depauperate variety of *agaricites*.

The entire group is a difficult one, and needs more study, with larger collections.

Maria Farinha, Pernambuco, No. 4522, type ; and Abrolhos Reefs, No. 4538, type, Yale Mus. (C. F. Hartt). No. 4538 includes three young examples on *Mussa Harttii.*

Siderastræa stellata Ver. See p. 155, and these Trans., i, pp. 352, 358.

PLATE XXX, FIGURES 4, 5.

Abrolhos Reefs, type, (C. F. Hartt) ; Pernambuco, Mar Grande, Bahia (R. Rathbun). Common everywhere north of Cape Frio, on the reefs, in shallow water, and in tide-pools (C. F. Hartt).

Var. **conferta** Ver. See p. 155

PLATE XXX, FIGURE 5

Abrolhos Reefs, type, (C. F. Hartt); occurs with the last.

Family **Poritidæ.** See p. 158.

Porites Verrillii Rehb. See p. 161.

PLATE XXXI, FIGURE 5.

Abrolhos Reefs, type, and Porto Seguro (C. F. Hartt); Pernambuco? (Rathbun).

Porites Branneri Rath. See p. 162.

PLATE XXXI, FIGURES 6, 6*a*.

Parahyba do Norte and Pernambuco (R. Rathbun).

Porites astreoides Les. See p. 160.

PLATE XXXI, FIGS. 4, 4*a* (typical form)

Var. **Braziliensis** Ver., nov.

The specimens from Pernambuco are thick incrusting plates, 125 to 150^{mm} broad, with an uneven surface, much infested with barnacles. The coral is very porous. The calicles are rather smaller than in the West Indian *astreoides*, and more crowded than usual in that form. They are mostly polygonal, separated by rather thin and high porous division walls, with a sharp crest, roughly denticulated by the tops of the septa, which are lacerately serrulate. Near the margins they are often less crowded, somewhat rounded, and separated by thicker division walls. A considerable number of major calicles, with 24 septa, are scattered over the surface, and some are undergoing fission.

The septa are narrow, equal, and all join the wide columella, so as to leave a rather regular circle of small, deep, interseptal loculi or pits. The columella is unusually wide, nearly flat, generally without either a central pit or umbo.

Diameter of the calicles mostly 1.5 to 2^{mm}.

Maria Farinha, Pernambuco (Hartt, 1870). No. 4540.

This coral is much more porous than *P. Verrillii*; the calicles are less conspicuously stellate; the division walls are much narrower and more porous; the columella is larger, and not umbonate, as in that species.

HYDROZOA.

HYDROCORALLIA.

Family **Milleporidæ** Flem., *pars*, 1828 Edw. & Haime (*pars*).

Millepora nitida Ver Pl. xxxvi D, fig 1

These Trans , i, p 362, 1867.

Abrolhos Reefs and Porto Seguro, low-tide to 4 feet deep (C. F. Hartt).

Millepora Braziliensis Ver Pl xxxvi D, fig. 2

These Trans , i, p 363, 1867.

Pernambuco and Abrolhos (C. F. Hartt, R. Rathbun).

Millepora alcicornis (L.), var **cellulosa** Ver

These Trans., i, p. 363, 1867.

Pernambuco (C. F. Hartt), type ; Rio Formosa ; Parahyba do Norte.

Millepora alcicornis (L.), var. **digitata**? Esper.

Verrill, these Trans., i, p. 364, 1867.

Abrolhos, Cape Frio, Porto Seguro, Bahia, and Maceió (C. F. Hartt).

Millepora alcicornis (L.), var. **fenestrata** D. & Mich

Verrill, these Trans , i, p. 364, 1867

Abrolhos Reefs (C. F. Hartt).

I have not revised the several forms of *Millepora* recorded by me in 1867, though collections since received might cause some changes or additions, if carefully studied.

Family **Stylasteridæ** Gray

Stylaster, sp.

Pernambuco, on *Mussa Harttii* (R. Rathbun)

Recorded only by Rathbun, Amer. Nat., xiii, p. 542, 1879.

Many of the corals in the above list undoubtedly occur on all the principal groups of reefs, from the Roccas, north of Cape St. Roque, to the Abrolhos, but I have given only those particular localities from which I have seen specimens, or from which they have been recorded by Prof. Hartt or Mr. Rathbun.

The following species of corals, dredged by the Hassler Expedition off the coast of Brazil, in moderate depths, were described by Pourtalès (Mem. Mus. Comp. Zoöl., iv, 1874). None of them are reef-corals:

Flabellum Braziliense Pourt., p. 38, pl. vi, figs. 16, 17.
Off Brazil, 11° 49′ S., 40 fathoms.

Sphenotrochus auritus Pourt., p. 37, pl. vi, figs. 14, 15.
Off Cape Frio, Brazil, 35 fath., and S. lat. 11° 49′, 12–18 fathoms.

Bathycyathus maculatus Pourt., p. 34, pl. vi, figs. 5, 6.
Off the Abrolhos Is., 30 fathoms.

Thecocyathus cylindraceus? Pourt.
Off Cape Frio, Brazil, 35 fathoms, dead.

Cladocora patriarca Pourt., p. 42, pl. vii, fig. 7.
Off Cape Frio, 35 fathoms.

Axohelia dumetosa D. & M.?. Pourt., pp. 40, 41, pl. viii, fig. 1.
Off Brazil, S. lat. 10° 49′, 12 fath., (identity doubtful, t. Pourt.).

Madracis asperula E. & H.; Pourt., p. 41. See above, p. 109; also, The Atlantic, i, p. 360, figure; and Vaughan, Porto Rico Corals, p. 234, pl. i, fig. 4, pl. xvii, fig. 2.
Off Brazil, S. lat. 11° 49′, 40 fathoms.

EXPLANATION OF PLATES X–XXXV.

The figures on these plates are reproduced from photographs made by Mr. A. Hyatt Verrill, of New Haven, who has taken unusual pains to bring out the finer details of structure.* The photographs necessarily lose many of the details by this process of engraving, but I believe they will show quite as much structure as many of the poorer photographs that are often reproduced by much more expensive processes, and certainly much more than can be shown by the best lithographic plates. Had the requisite funds been available, I should have preferred to have enlarged many of them considerably more, in order to show finer details.

PLATE X.

Figure 1.—*Mæandra labyrinthiformis* (Linné). Top view of a Bermuda specimen showing both single and double collines of various breadths. In several places it also shows the commencement of the formation of exothecal buds and calicles on the double collines. Natural size. Page 70.

Figure 2.—The same. Part of a young Bermuda specimen with nearly all the collines simple (var. *truncata* Dana). About $\frac{2}{3}$ natural size. Page 72.

Figure 3.—Part of a young Bermuda specimen with wide double collines (var. *Stokesii*). On several of the wider places exothecal buds were forming. About $\frac{2}{3}$ natural size. Page 72.

Figure 4.—*Mæandra cerebrum* (Ellis and Sol.) Ver. Vertical section of a Bermuda specimen. ×3. Page 74.

PLATE XI.

Figure 1.—*Mæandra areolata.* Top view of a large Florida specimen, No. 1833*c*, with sinuous, meandriform valleys and *Diploria-like* collines; *a*, profile view of an attached *Favia fragum* (young). Slightly reduced ($\frac{4}{5}$). Page 81.

Figure 2.—The same, Var. *confertifolia* Ver., nov. Side view of the type, No. 1833*b*, from Key West, Fla. Natural size. Page 83.

PLATE XII.

Figure 1.—*Mæandra areolata*, var. *laxifolia* Ver. Top view of the type from Florida. No. 1833*a*. About natural size ($1\frac{1}{8}$) Page 83.

Figure 2.—The same. Var. *hispida.* (Type of *Manicina prærupta* Dana, No. 4294.) Top view, slightly enlarged ($\times 1\frac{1}{3}$). Page 83.

Figure 3.—The same. Variety with double collines and cellular exotheca. About natural size ($\frac{7}{8}$). Page 81.

Figure 4.—*Mæandra cerebrum.* Top view of a part of a typical Bermuda specimen. Natural size. Page 74.

Figure 5.—*Mæandra labyrinthiformis*, var. *Stokesii.* Portion of a Bermuda specimen showing the beginning of several exothecal buds, at *a*, *b*, *c*, *d*. About natural size ($1\frac{1}{8}$). Page 71.

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* The reproductions have been made by The Gill Engraving Co., New York.

Plate XIII.

Figures 1, 2.—*Favia fragum.* Two varieties found together at Bermuda ×1⅙. Page 90.

Figure 3.—*Favia gravida.* Type. Top view of a part of one of the original specimens, No. 1465. ×2. Page 91.

Figure 4.—*Favia leptophylla* Ver. Top view of a part of the type. No. 1517. ×$2\frac{1}{12}$. Page 91.

Figure 5.—The same specimen. Vertical section. ×$2\frac{1}{12}$.

Figure 6.—*Mæandra conferta* Ver. Top view of part of one of the types. No. 1466 ×2. Page 84.

Plate XIV.

Figures 1, 1*a*.—*Mæandra Agassizii.* Top views of different parts of one Bahama specimen. No. 5615. 1, natural size; 1*a*, enlarged about 1⅙ Page 81.

Figure 2.—*Mæandra clivosa*, var. *explanata* Ver , nov Top view of a part next the margin of No. 1196. About natural size ($1\frac{1}{16}$). Page 79.

Figure 3.—*Mæandra spongiosa* (Dana). Top view of a part of the type, No. 4388. Natural size. Pages 69, 80.

Figure 4.—*Mæandra cerebrum.* Top view of the middle of a Bermuda specimen with acute narrow collines Reduced to about ⅙. Page 74.

Figure 5.—The same. Portion of a Florida specimen, No. 1901, showing the formation of astreiform calicles (*a*, *b*) by exothecal budding. ×1⅙. Page 75.

Figure 6.—*Madracis decactis* (Ly.). End of a lobate branch, showing an exceptionally large calicle, with numerous septa, surrounded by those of ordinary size, but here crowded and without cœnenchyma between them. ×4. Page 108.

Plate XV.

Figure 1.—*Orbicella annularis.* Portion of upper surface of a Bermuda specimen. *A*, A calicle undergoing fission. Enlarged 1⅙. Page 94.

Figure 1*a*.—The same specimen. Natural size.

Figure 2.—The same. Var. *stellulata* (Dana). Portion of Dana's type, with worn surface, No. 4266; *a*, a transverse section. ×2⅙. Page 96.

Figure 3.—*Orbicella hispidula* Ver., sp. nov. Portion of the surface of the type, No. 98. ×1⅙. Page 100.

Figure 3*a*.—The same specimen. ×2⅙.

Figure 3*b*.—The same specimen; vertical section. ×2⅙.

Figure 4.—*Orbicella excelsa* Dana. One of the distal lobes of one of the original types, No. 1729. ×1⅙. Page 98.

Figure 4*a*, 4*b*.—The same specimen. ×2⅙.

Figure 5.—*Solenastræa hyades* (D.). Side view of a specimen from St. Thomas. No. 1586*b*. ×1⅙. Page 104.

Figure 5*a*.—The same specimen. About natural size ($1\frac{1}{12}$).

Figure 5*b*.—The same specimen. Group of calicles from the side, where not crowded. ×1⅙.

Plate XVI.

Figure 1.—***Mussa (Isophyllia) fragilis*** D. Side view of Dana's original type, No. 4298. Natural size. Page 121.

Figure 2.—The same. A well-grown normal specimen, from the Bermudas. Natural size. Page 121.

Plate XVII.

Figures 1, 2.—***Mussa (Isophyllia) fragilis*** Dana. Top and bottom views of a symmetrical young specimen, having five primary lobes or infoldings of the margin. About natural size. Page 124.

Figure 3.—The same. A young specimen of about the same age, having 6 marginal folds, with the margin stellate below. About natural size. Page 124.

Figure 4.—The same. A younger specimen with four marginal folds. About natural size.

Figure 5.—The same. A large mature Bermuda specimen, with numerous calicles, many isolated, $\frac{1}{3}$ natural size. Page 121.

Figure 6.—The same. A similar but smaller Bermuda specimen, reduced to $\frac{1}{3}$. Page 121.

Figure 7.—The same. A specimen of the more common size and form, $\frac{1}{3}$ natural size. Page 121.

Plate XVIII.

Figure 1.—***Mussa (Isophyllia) fragilis*** Dana. A symmetrical young specimen with six primary marginal infoldings. Natural size. Page 121.

Figure 2.—***Mussa (Isophyllia) dipsacea*** Dana. A normal, nearly regular Bermuda specimen of the ordinary size. Natural size. Page 118.

Figure 3.—***Axohelia Schrammii*** Pourt. Part of a branch of No. 5662. $\times 2\frac{1}{3}$. Page 110.

Figure 4.—The same. Part of a branch. No. 5662. $\times 2$. Page 110.

Figure 5.—***Mussa (Isophyllia) dipsacea*** Dana. Part of the calicles of a large Bermuda specimen, to show character of dentition. Natural size.

Figure 6.—***Mussa (Isophyllia) fragilis*** Dana. Part of the under side, to show character of the costæ and of the epitheca (*e*). About natural size.

Plate XIX.

Figure 1.—***Mussa (Isophyllia) fragilis*** Dana. A young Bermuda specimen with double, partly separate walls, much like the type, but more regular in form. About natural size. Page 123.

Figure 2.—***Mussa (Isophyllia) dipsacea*** Dana. A Bermuda specimen with the calicles mostly isolated and the walls only partly united. Natural size. Page 120.

Figure 3.—The same. A young specimen with three primary infoldings, just developing. Enlarged about $1\frac{1}{10}$. Page 118.

Figure 4.—***Mussa (Isophyllia) fragilis*** (?). A young five-lobed example, with the infoldings appearing earlier than usual in this species, and therefore resembling *M. multiflora*, to which it may belong. Natural size. Page 121.

Figure 5.—The same (?). A young, simple, undivided example, probably of *M. fragilis*, in the *Scolymia* or *Lithophyllia* stage. × 1½. Page 124.

Figure 6.—*Mussa (Isophyllia) fragilis* (Dana). A young, typical Bermuda specimen. × 1½.

Figure 7.—*Mæandra cerebrum*. Oblique view of a few collines to show dentition of septa. From same specimen as fig. 5, pl xiv An exothecal calicle is shown at *b*. About natural size,

PLATE XX.

Figure 1.—*Mussa (Isophyllia) dipsacea* Dana. A Bermuda specimen with unusually large and shallow calicles. Side view. About $\frac{8}{10}$ natural size. Page 120.

Figure 2.—*Mussa (Isophyllia) multiflora* Ver., sp. nov. The best type. Natural size. Page 125.

PLATE XXI

Figure 1.—*Mussa (Symphyllia) Braziliensis* Ver. Part of the upper surface of the type. No. 1467. Natural size. Page 192.

Figures 2, 2*a*.—*Mussa (Symphyllia) hispida* Ver , sp. nov. Portions of the upper surface, No. 4287. × 1½. Page 127.

Figure 2*b*.—The same specimen. Transverse section. × 1⅞.

Figure 2*c*.—The same specimen. Vertical section. × 2½.

Figure 3.—*Mussa (Symphyllia) tenuisepta* Ver., sp. nov. Part of the surface of the type. No. 4542. About 1⅞ natural size. Page 198.

PLATE XXII.

Figure 1.—*Mussa Harttii*, var. *confertifolia* Ver., nov., with corallites partly free. Type, No. 4544. About natural size. Page 129.

Figure 2.—*Mussa Harttii*, var. *intermedia* Ver., nov., with corallites partly united proximally. About natural size. Page 128.

PLATE XXIII.

Figure 1.—*Mussa Harttii* Ver., var. *conferta* Ver., nov. One of the types. No. 4514. From Bahia. About natural size. × 1¼. Page 128.

Figure 2.—The same. Var. *laxa* Ver., nov. Type. No. 1468. Natural size. Page 128.

PLATE XXIV.

Figure 1.—*Callogyra formosa* Ver., sp. and gen. nov. Type.* Upper side. About natural size ($\frac{9}{10}$). Page 86.

Figure 2.—The same specimen. Under side. $\frac{9}{10}$.

* Mr. R. P. Whitfield is quite positive that this specimen came from the Bahamas.

PLATE XXV.

Figure 1.—***Mussa*** (*Isophyllia*) *multiflora* Ver., sp. nov. A young specimen (No. 4009). Natural size. Page 126

Figure 2.—***Mussa*** (*Symphyllia*) *rigida* (Dana). Type of Dana. No. 4297 Transverse section. × 2. Page 127.

Figure 3.—The same. A fresh Bahama specimen, in Amer. Mus Nat. Hist. Natural size. Page 128.

Figure 4.—***Mussa*** *Harttii*, var. *conferta* Ver. Vertical section of type. × 2. Page 128

Figure 5.—***Favia*** *Whitfieldi* Ver., sp. nov. Type, in Amer. Mus Nat. Hist. No. 548. Natural size. Page 132.

PLATE XXVI.

Figures 1*a*, 1*b*.—***Agaricia*** *fragilis* Dana, from Bermuda. Upper and under sides of two symmetrical young specimens of ordinary size and form. Reduced to ⅔. Page 142.

Figure 1*c*.—The same. Upper side of a specimen with two primary calicles, perhaps due to the early coalescence of two young specimens. Page 142.

Figure 1*d*.—The same. Side view of two small specimens. All the above reduced to about ⅔ natural size. Page 142.

Figure 2.—***Agaricia*** *agaricites*, var *agaricites*. Part of the surface of a large frondose specimen. No. 5671 (= fig. 7, pl. xxvii). From the Bahamas. × 3. Page 146.

Figure 3.—The same. Var. *Danæ* E. and H. Part of the surface of a frond from a large Bahama specimen (= fig. 6, pl. xxvii). × 3. Page 147.

PLATE XXVII.

Figure 1.—***Agaricia*** *agaricites*, var *gibbosa* D. Part of Dana's type from Barbados. No. 1860. Side view of a terminal lobe. Natural size. Page 148.

Figure 1*a*.—The same specimen. Calicles, × 1½.

Figure 2.—***Agaricia*** *agaricites*, var *agaricites*, young. About half of a small incrusting Florida specimen. No. 103. Natural size Page 147.

Figure 2*a*.—The same specimen. Calicles, × 1⅔,

Figure 3.—***Agaricia*** *agaricites*, var. *pusilla* V., nov. Part of the type From Colon. No. 1487. Natural size. Page 148.

Figure 3*a*.—The same specimen. Part of upper side. × 1⅔.

Figure 4.—***Agaricia*** *purpurea* Les., var. *faveolata* V , nov. Upper surface of one of the types. No. 1201. From Colon. × 1⅔ Page 149.

Figure 4*a*.—The same specimen. Vertical section. × 1⅔.

Figure 5.—***Agaricia*** *agaricites*, var. *Danæ* E. and H. Part of Dana's type. No. 4301. × 1½. Page 147.

Figure 6.—The same variety. Part of a large frond from the Bahamas. × 1½.

Figure 6*a*.—The same specimen. No 5672. A group of calicles, × 5

Figure 7.—***Agaricia*** *agaricites*, var. *agaricites*. Part of a frond from a large, frondose, Bahama specimen. No. 5671. × 1⅔. Page 147.

Figure 7*a*.—The same specimen. Calicles, × 5.

Figures 8, 8*a*.—***Asteroseris*** *planulata* (Dana) Ver. Small portions of Dana's type. No. 4309. × 3. A transverse section is shown at *b*. Page 156.

Plate XXVIII.

Figure 1.—*Agaricia nobilis* Ver., nov. Type No. 850, from Turks I. Reduced to $\frac{3}{5}$. Page 150.

Figure 2.—The same specimen. Part of upper surface. $\times 1\frac{1}{8}$.

Plate XXIX.

Figures 1, 1*a*. 1*b*.—*Mycedium explanatum* Ver, nov. Parts of upper side of type, No. 6173. $\times 1\frac{1}{10}$. Page 136.

Figure 1c.—The same specimen Vertical section. $\times 1\frac{3}{8}$.

Figure 1*d*.—The same specimen Under side, near margin. Natural size.

Figures 2, 2*a*, 2*b*—*Mycedium tenuicostatum* Ver., nov. Parts of upper side of type, No. 6174. $\times 1\frac{1}{10}$ Page 187.

Figure 2c.—The same specimen. Vertical section $\times 1\frac{3}{8}$.

Figure 2*d*.—The same specimen. Under side Natural size.

Figure 3, 3*a*.—*Echinopora elegans* Ver., nov. Parts of the upper side of the type, No. 6180. $\times 2\frac{1}{2}$. Page 138.

Figure 4.—*Echinopora concinna* Ver, nov. Part of upper side of the type, No. 6182. $\times 2\frac{1}{2}$. Page 139.

Figure 5.—*Podobacia dispar* Ver., nov. Part of the upper side of the type, No. 6178, towards the margin. $\times 1\frac{3}{4}$. Page 186.

Figure 5*a*.—The same specimen Under side. Natural size.

Plate XXX.

Figure 1.—*Siderastræa radians*. Group of calicles, from a Florida specimen. No. 1901. $\times 2\frac{1}{4}$. Page 153.

Figure 2.—*Siderastræa siderea*. Group of calicles from a West Indian specimen. No. 1838. $\times 2\frac{1}{4}$. Page 151.

Figure 3.—*S. siderea*, var *nitida* Ver., nov. Group of calicles from the type. No. 1028, from Colon. $\times 2\frac{1}{4}$. Page 152.

Figure 4.—*S. stellata* Ver. Group of calicles from one of the types, No. 1464,• from Brazil. $\times 2\frac{1}{4}$. Page 155.

Figure 5.—*S. stellata*, var. *conferta* Ver. , Group of calicles from one of the types, No. 1464*a*, from Brazil. $\times 2\frac{1}{4}$. Page 155.

Figure 6.—*Agaricia crassa* Ver. Groups of calicles from the type, No. 514, Am. Mus., from near Nassau. $\times 2$. Page 145.

Plate XXXI.

Figures 1, 1*a*.—*Plesiastræa Goodei* Ver. Groups of calicles from the Bermuda type. No. 6628. $\times 5$. Page 106.

Figure 2.—*Cyphastræa nodulosa* Ver. Side view of the type. No. 542, Amer. Mus., and No. 6625, Yale Mus. From near Nassau, N. P. $\times 1\frac{1}{2}$. Page 107.

Figures 2*a*, 2*b*.—The same specimen. Groups of calicles, $\times 4$.

Figures 3, 3*a*.—*Porites polymorpha* Link. Groups of calicles from a Bermuda specimen. $\times 4$. Page 158.

Figures 4, 4*a*.—*Porites astreoides* Les. Groups of calicles from a Bermuda specimen. $\times 4$. Page 160.

Figure 5.—*Porites Verrillii* Rehb. Group of calicles from the type of Verrill. No. 4589. From the Abrolhos Reefs. ×4. Page 161.

Figures 6, 6*a*.—*Porites Branneri* Rath. Groups of calicles from a Pernambuco specimen. No. 4552. ×4. Page 162.

PLATE XXXII.

Figure 1.—*Acropora muricata*, var. *surculo-palmata* Ver. Top view of a West Indian specimen No. 6621, having a cluster of var. *prolifera* growing up from a frond of var. *palmata*. Reduced to about $\frac{1}{3}$. Page 165.

Figure 2.—*Oculina varicosa* Les. Branch of a Bermuda specimen, showing prominent corallites on one side and low circumvallate ones on the other side at x, x, x. Natural size. Page 173.

Figure 3.—The same. Part of a branch with more swollen corallites. $\times \frac{1}{1}$.

Figure 4.—The same. Var. *conigera* Ver., nov. Part of the type. From Bermuda No. 4495. $\times 1\frac{1}{8}$. Page 175.

Figure 5.—*O. Valenciennesii* ? Part of a branch of a Bermuda specimen with low circumvallate corallites No 1811. $\times 1\frac{1}{3}$. Page 176.

PLATE XXXIII.

Figure 1.—*Orbicella aperta* Ver. Group of calicles from the type. No. 1518. From the Abrolhos Reefs. ×2. Page 103.

Figure 1*a*.—The same specimen. Vertical section. ×2.

Figure 2.—*Orbicella cavernosa*, var. *hirta* Ver. Calicles of the type, No. 4517 from Brazil, 1876. $\times 1\frac{2}{3}$. Page 189.

Figure 3.—*Mussa Harttii*, var. *conferta*, growing out from a branch of var. *laxa*. No. 4545. From Brazil. About natural size ($1\frac{1}{8}$). Page 128.

Figure 4.—*Mussa* (*Symphyllia*) *Braziliensis* Ver. Group of calicles from the type. No. 1467. About natural size. Page 192.

PLATE XXXIV.

Figure 1.—*Meandrina Braziliensis* (E. and H.) Vaughan. A mature specimen from Bahia. No. 4548. About natural size ($\frac{1}{1}\frac{1}{8}$). Page 190.

Figure 2.—*Agaricia crassa* Ver., sp. nov. Side view of one of the types. From Nassau, N. P., No. 514, Amer. Mus. About natural size. Page 145.

PLATE XXXV.

Figure 1.—*Mussa annectens* Ver., sp. nov. Part of one of the types. From Bermuda. $\times 1\frac{3}{4}$. Page 178.

Figure 2.—The same specimen. Natural size.

[Cuts in the text, Nos. 3, 8, 9, 10, 18; and 4, 5, 6 of Article II, were loaned by the publishers of Webster's International Dictionary. The others are original.]

ADDENDA.

Since this article was put in type I have corresponded with Dr. T. W. Vaughan, in regard to various debated cases in the nomenclature of the West Indian Reef Corals, concerning which we did not agree, as stated above in Article III See also note, p 169

He has recently authorized me to state that he now agrees with my determinations in the following cases :—

Mæandra versus Platygyra P. 66–68.

He accepts the former name, as restricted by me (p. 66), instead of *Platygyra*, and also agrees with me as to the necessity of uniting to it *Diploria*, *Manicina* (auth.), and *Cœloria* (See p 67)

Acropora versus Isopora. P 164, 208

He accepts the name *Acropora* for this genus, as restricted (p. 164) instead of *Isopora* He also agrees with me as to the restriction of *Madrepora* to the type of *M oculata*, = *Amphihelia* and *Lophohelia*. See pp. 110–113

Madracis versus Axohelia P. 109.

He accepts the former, as having priority.

Orbicella annularis versus O acropora. P. 94, 95.

He agrees with me as to the propriety of using the former name.

In respect to the restriction of *Meandrina* to the type of *M. meandrites*=*Pectinia* auth. we were already in accord (p. 66). Also in the use of *Favites* for *Prionastræa* (p. 92); and in the union of all known West Indian forms of *Acropora* under the name *muricata* (p. 165). On some other minor points we no longer differ.

But he does not, at present, agree with me in the use of *Mæandra cerebrum* in place of *M. viridis*, on the ground that he does not consider the description of Ellis and Solander sufficient for the identification of the species. (See pp. 74, 77.)

Nor does he agree with me as to the use of *Porites polymorpha* (p. 158), instead of *P. porites* or *P. clavaria*. He believes that Ellis and Solander practically restricted *porites* to the type of *clavaria*. If their treatment of the species can be considered as such a restriction, then the name properly should hold for this species. But I have not hitherto considered that Ellis and Solander intended to separate the West Indian form from others, but that they merely described the form that they had from the West Indies as an *example* of the species. This point is a debatable one.

Mr. Vaughan's family name *Favidæ* is equivalent to my *Mæandridæ* (p. 65), and has priority. His use of the family name *Orbicellidæ* also has priority over my identical use of it (p. 93).

V.—Notes on Corals of the genus Acropora (Madrepora Lam.) with new Descriptions and Figures of Types, and of several New Species.

By A. E. Verrill.

Many changes in the nomenclature of this great and difficult genus have recently been made, especially in the extensive descriptive catalogue by Brook. But in consequence of the new determinations of many of the species by him, and of his redescriptions of a number of the types of Ehrenberg, Edw. and Haime, Quelch, and others, it has become very desirable to compare the types of Dana and other American writers with his new descriptions.

It is certain that there is still great confusion among writers on corals as to the character and limits of many of the species of this genus, and especially as to the application of the names given by Lamarck, Ehrenberg, and other early writers to some of the species. Such Lamarckian names as *laxa*, *abrotanoides*, *corymbosa*, and others have each been applied to a dozen or more species, by as many different writers.

This is due partly to the total lack of figures of many of the older types, and partly to the very short and imperfect descriptions. Brook has done great service by redescribing in detail many of these original types, in the museums of Berlin, Paris, and the British Museum. But if he could have figured them, his work would have been of much greater value.

Now that photographs of corals can be so easily and cheaply reproduced, it is to be hoped that all the extant types will soon be illustrated.

At this time, owing to the lack of funds for the purpose, I am able to give figures of only a few of the types in our museum, but I hope that more work of this kind can be done at no distant time.

In this article I have undertaken to redescribe only a few selected out of the whole number of Dana's types that are in the Yale Museum,* selecting those in respect to which European writers have made the most mistakes, and those which Dana did not figure. I

* The principal set of Dana's types is in the U. S. Nat. Museum Those have been enumerated by Mr. R. Rathbun, Proc. U. S. Nat. Mus., x, 1887. But he did not redescribe them.

have also given additional descriptions of several of my own types, described in 1864–68, and on the type of *A. tubigera* (Horn, 1860) I have added descriptions of several new species.

A number of these types are here figured from enlarged photographs, made by Mr. A. Hyatt Verrill.

Acropora Oken (restr.) Type, *A. muricata*.

Madrepora (*pars*) Lam., Syst. Anim., p. 371, 1801 (*non* Linné, ed. x). Lam., Hist. Anim. s. Vert., ii, p. 277, 1816. Dana, Zooph., p. 485, 1846. Edw. and Haime, Hist. Corall., iii, p. 132, 1860 (*non* Ehr.).

Acropora (*pars*) Oken, Lehr. Naturg., p. 66, 1815 (type, 3d species = *A. muricata*).

Madrepora Brook (with ten subgenera), Cat. Mad. Brit. Mus., i, p. 23, 1893.

Isopora Vaughan, Fossil Corals Curacoa, etc., p. 68, 1901. Stony Corals Porto Rican Waters, Bull. U. S. Fish Comm. for 1900, ii, p. 312, 1901.*

On pages 110–113 and 164, I have given reasons for displacing *Madrepora* as the name of this genus, and for the substitution of *Acropora* Oken.

In brief they are these:

1st. No recognized species of this genus was included in *Madrepora* by Linné, in his Syst. Nat., ed. x.

2d. *M. muricata* (auth.), which originally included all the known species of *Acropora*, was put under *Millepora* in the ed. x, though placed in *Madrepora* in ed. xii, as also by Pallas. Therefore it cannot properly be taken as the type of *Madrepora* if the ed. x is to be used as the starting point of the binomial system.

3d. Lamarck, in 1801, gave only two species as examples of *Madrepora*, viz: *M. muricata* and *M. porites*. The latter was made the type of the genus *Porites* by Link, in 1807, otherwise it might have been adopted for the type of *Madrepora*.

4th. Oken, in 1815, proposed the genus *Acropora*, including three species, of which the third was *A. muricata*. This can be adopted as its true type, because the second had already been placed in *Porites* by Link, 1807; and the first was placed in *Pocillopora* by Lamarck, in 1816. This leaves the name *Acropora* clearly available for the great genus of which *A. muricata* is the type.

The genus *Acropora* (restr.) is characterized by the presence of at least two forms of corallites. In all branched forms there is a sym-

* Mr. Vaughan has recently authorized me to state that he now accepts the name *Acropora* for this genus, instead of *Isopora*. See p. 206.

metrical and usually larger axial corallite at the end of each branch (sometimes more than one), which produces radial or lateral buds around its base. These buds mostly develop into a symmetrical, often one-sided or labiate radial corallites in which the zoöids may have longer directive tentacles and wider directive septa.

More or less of the radial corallites become larger and symmetrical and eventually may become the axial corallites of new branches or branchlets.

Other radial corallites, without prominent lips, often occur on the larger branches, or on their under sides, wholly immersed in the cœnenchyma.

Most, if not all, of the species when young form incrusting groups or plates. In this stage new corallites are formed around the margins from exothecal buds. Massive or unbranched species sometimes have scattered axial corallites, scarcely more prominent than the others.

The porous cœnenchyma is usually scanty in the smaller branches, but often becomes abundant in the basal mass and larger branches.

The septa are usually 12, in two cycles, those of the second cycle being narrow and thin, and often rudimentary or entirely lacking. The directive septa are usually wider than the others, and often unequal. Sometimes all the septa are nearly abortive.

In several species a few larger or giant calicles occur, with 24 septa.

The surface of the cœnenchyma varies much in character and often furnishes useful specific characters, but it is liable to vary on different parts of a single specimen, according to age and other conditions. It is commonly porous or pitted, and more or less thickly covered with minute rough or sharp spinules or granules.

The walls of the corallites may be regularly costulate, or else covered with granules, either in rows or densely grouped. These differences afford useful specific characters, but are liable to vary.

Brook (Cat. Mad., 1893) recognized 220 species. Probably many of these will be united when larger series can be compared. Probably Brook has attached too much importance to variations in modes of growth.

I have studied about 120 species, most of which seem valid, including those described by Dana, a number of the types of Edw. and Haime, and many others from China, the East Indies, Ceylon, Red Sea, etc. But of many of these I have not seen good series.

The types of most of Dana's species collected by the U. S. Expl. Exped. are in the U. S. National Museum. The first series of the duplicates of that collection was early given to Professor Dana for

the Museum of Yale University. These I found in the original packages, with Dana's labels, when I took charge of them in 1864.

A second series of duplicates was selected from the collections in the National Museum (then in the Smithsonian Inst.) by me in 1860, under the direction of Professor S. F. Baird, for the Museum of Comparative Zoölogy.

The types of Dana's species received from other sources are mostly in the Museum of Yale University. The most important of these came from Point Pedro, Ceylon, collected in 1843, by the Rev. George H. Apthorp, who was a missionary there, 1833 1844. His letters relating to this valuable collection are still preserved in the museum.* Some of the specimens recorded by Dana as from "Singapore" probably were from this collection, but others were correctly recorded as from Ceylon:—e. g. *M. effusa*, *M. plantaginea*, *M. efflorescens.* The locality-labels of some of the Ceylon specimens were lost before Dana studied them.

The types of my own species, from the U. S. North Pacific Expl. Exped., are in the Nat. Mus., but duplicates or fragments of most of them are also in the Museum of Yale University. Other species described by me in 1864–1866 are in the Museum of Comparative Zoölogy and Yale Museum. The species studied by me from the Red Sea were mostly in the Ward collection, afterwards purchased by the Field Columbian Museum of Chicago, but duplicates or fragments of many of them are also in the Yale Museum.

All the West Indian forms seem to be mere growth-varieties of one polymorphic species. See *A. muricata* and varieties, pp. 165–168.

* The Rev. George H. Apthorp, of the American Ceylon Mission, was born May 31st, 1798, at Quincy, Mass.; died at Oodoopitty, Ceylon, June 8th, 1844. He graduated at Yale College in 1829, and at Princeton Theol. Seminary in 1832. Sailed for Ceylon July 1833, arriving there in Oct 1833.

He was a very devout man and a devoted missionary, laboring, apparently, in a very barren and unpromising field, under many and great disadvantages.

The collection of corals was made at Point Pedro, about 7 miles from Varany, where he was then stationed with his wife, who aided in obtaining and bleaching the corals, and also in making a collection of shells sent with them.

In his letters of 1843, to Prof. Benj. Silliman, Sr., he mentions some of the difficulties encountered, both in obtaining and also in packing the corals, for no suitable packing materials could be had, except the cast-off garments of the girls in the mission school. His specimens arrived in good condition, however.

He also states that no other corals had ever been sent away from that locality. Some of the species sent by him are still very rare in collections, as for example, *Pocillopora grandis* D.

Notes on the Distribution and Subdivisions of Acropora.

The following list contains most of the species that I have personally studied, with their principal recorded localities. It is probable that most of the East Indian species have a very wide distribution, though at present recorded from only a few localities, or perhaps from only one. Many species are known to range from Singapore to Tahiti or the Fiji Is., or even to the Great Barrier Reef, and to the Red Sea. Probably many others will be found to have as great a range, when more fully collected.

This wide distribution, and even a greater one, is well known to occur, also, in the case of numerous mollusks, echinoderms, etc., characteristic of the Indo-Pacific fauna.

But it is probable that local variations, especially in growth-forms, will occur in the same coral when found in widely separated localities, as is the case in other groups. Probably many of these growth-variations have been described as distinct species, but without a large series of specimens it is not possible to determine this, in most cases. The variations of *A. muricata* in the West Indies should serve as a caution against overestimating the importance of mere forms of growth in corals of this genus and others.

Many mollusks and echinoderms of the East Indian fauna range to Australia, Africa, and even to the Hawaiian Islands. But I have never seen an authentic specimen of *Acropora* from the Hawaiian Islands. Local collectors assert that the genus does not occur there. But great quantities of corals, etc., are brought from the Polynesian Islands to Honolulu by the missionary vessels and sold there as curiosities.

Many corals, seen in collections, labelled as from the Hawaiian Islands, have been obtained in this way, but are natives of the Caroline Islands, Ebon Island, the Kingsmills Islands, etc. This is especially the case with ornamental species, like *Stylaster elegans* V., *Distichopora nitida*, etc.

Probably this was the case with the several species of *Acropora*, recorded from the Hawaiian Islands by Brook. Their occurrence there certainly needs confirmation, for in the large authentic collections of corals that I have studied from those islands no *Acropora* has occurred.

Specimens of corals are brought to Singapore from long distances by the natives, for sale, and thus may be recorded from there erroneously.

Similarly, species of this genus have been recorded from St. Helena, the White Sea, etc., where they probably do not live.

Though some of the ten "subgenera" of Brook are useful divisions, for diagnostic purposes, others are not of any practical value, and often serve more to mislead than to help the student. This remark applies particularly to those based on slight differences in the mode of growth or branching, and on small variations in the size or prominence of the terminal or axial corallites. One part of a single specimen will often go in one such "subgenus," while another part will go in another.

The forms of the radial corallites; the texture of the cœnenchyma; and the presence or absence of distinct costæ, would give more constant characters for the differentiation of sections of the genus.

For this reason much enlarged photographic figures of the calicles and cœnenchyma are of the greatest value in illustrating species of this genus. Drawings seldom give the complex texture satisfactorily. Young specimens of all the profusely branched species appear totally unlike the mature forms, and are, therefore, apt to be erroneously determined.

List of Species of Acropora examined.

I have arranged the species alphabetically, for greater convenience of reference.

An asterisk prefixed, indicates that the species is in the Museum of Yale University.

Authorities for names and localities are often much abbreviated: B.=Brook; D.=Dana; E. and H.=Edw. and Haime; Kl.=Klunzinger; Q.=Quelch; R.=Rehberg; St.=Studer; V.=Verrill.

**Acropora abrotanoides* (Lam., *non* Dana, see *polymorpha*). Brook, op. cit., p. 56, 1893.

Singapore (B.); Polynesia; Tahiti (B.); Great Barrier Reef (B.).

*A. *acervata* (Dana). Brook, p. 147. See notes, below.

Singapore (D., V.).

**A. aculeus* (Dana). Brook, p. 104.

Fiji (D.); Philippines ? (Quelch).

**A. acuminata* (Ver.) Brook, p. 38. See notes, below.

Kingsmills Is. (Ver.).

**A. alliomorpha* (Brook, p. 87). Singapore (B.).

**A. amblyclados* (Brook, p. 140).

Singapore, Indian O., and Australia (B.).

**A. appressa* (Ehr., D., not *apperea*, as in Edw. and H.) Brook, p. 85. See notes, below.

Singapore and Ceylon (D., V.). Loc. of type unknown.

**A. Arabica* (E. and H.) Brook, p. 66.
Red Sea (E. and H.); Seychelles (B.).

**A. arbuscula* (D.) Brook, p. 40. See notes, below.
Singapore (D., V., B.); East Indies; Sulu Sea (B.); Great Barrier Reef (B.).

**A. arcuata* (Brook, p. 102, pl. xii).
Samoa (Br.); Fiji ? (V.).

**A. armata* (Brook, p. 100; *non M. spicifera*, Var., D., pl. 33, figs. 4, 4*a*, young). Brook, p. 100. See *A. cytherella* and *A. turbinata* in notes, below.
Singapore; Tahiti (B.); Fiji ?; Diego Garcia (B.). Perhaps not distinct from *turbinata*.

A. aspera (D.) Brook, p. 62.
Fiji (D.); Philippines (Q.); Great Barrier Reef (B.); New Hanover (B.).

**A. assimilis* (Brook, p. 85, pl. xx, fig. A. = *M. appressa* D., *non* Ehr., t. Brook). See notes, below.
Singapore (D., V.); Ceylon (V.); Amboina (Q.).

**A. austera* (D.) Brook, p. 56. See notes, below.
Singapore (B.); Philippines ? (Q).

**A. brachiata* (D.) Brook, p. 43.
E. Indies; Sulu Sea (D.); Fiji, Sumatra, etc. (B.).

A. calamaria (Brook, p. 154, pl. xxiii, A, B.).
Rodriguez (B., type).

A. Brueggemanni (Brook, p. 145, pl. xxiv, xxxv) = *M. laxa* Brug., *non* Lam.
Singapore (type, B., V.); Torres St. and G. Barrier Reef (B.).

**A. canaliculata* (Klz.) Brook, p. 151.
Red Sea (Kl.); G. Barrier Reef (B.).

**A. carduus* (D.) Brook, p. 178.
Fiji (Q.); New Britain (B.); Mauritius (B.); ? Australia (B.).

**A. cerealis* (D.) Brook, p. 91.
Sooloo Sea (D.); Singapore (B.); Amboina (B.); Ternate (B.); Samoa, Fiji, and Tongatabu (B.); Great Barrier Reef (B.); Mauritius and Seychelles (B.).

A. clathrata (Brook, p. 49, pl. v, vi).
Mauritius (B.).

A. concinna (Brook, p. 165, pl. xvii).
Mauritius, type, and Amirante Is. (B.).

A. conferta (Q.) Brook, p. 108.
Fiji (Q.); Tongatabu, Torres St., Amirante Is., and Great Barrier Reef (B.).

**A. confraga* (Q.) Brook, p. 182.
Fiji (Q.); Malacca (B.); Pelew I. (V.).

**A. conigera* (D.) Brook, p. 34.
Singapore (D., V.).

**A. convexa* (D.) Brook, p. 118.
Singapore (D., V.); Cebu I. and Ceylon (V.); Tongatabu and G. Barrier Reef (B.).

**A. corymbosa* (Lam., *non* Dana) Brook, p. 97. See *surculosa*.
Indian O.; Red Sea (Kl., B.); Rodriguez (B.); Zanzibar ? (V.); China (B.); Tahiti (B.); Great Barrier Reef (B.); Fiji (B.); Ramesvarum (B.); Tizard Bank (B.).

A. cribripora (D.) Brook, p. 123.
Fiji (D.); Tongatabu and Gr. Barrier Reef (B.).

**Acropora cucullata* Ver., sp. nov. See notes, below.
Indo-Pacific (V.).

A. cuneata (D.) Brook, p. 134.
Fiji (D., Q., B.); Great Barrier Reef (B.).

**A. cuspidata* (D.) Brook, p. 124.
Tahiti (D.); Ponapé (B.).

**A. cyclopea* (D.; not *cycloptera*, as in E. and H.) Brook, *pars*, p. 33.
Wakes I., Pacific O. (D., V.). Not West Indian, as in Brook.

**A cytherea* (D.) Brook, p. 99.
Tahiti (D., V.); Singapore (D., B.); Solomon Is. (B.); Ceylon (B.); Mauritius (B.); Red Sea (Kl., B.); Diego Garcia (B.).

**Acropora cytherella* Ver., sp. nov. (=*M. spicifera* D., var.). See notes, below.
Tahiti (D.).

**A. Danæ* (E. and H., Ver.,=*M. deformis* D., *non* Mich.) Brook, p. 57.
Tahiti (D.).

**A diffusa* (Ver.) Brook, p. 80. See notes, below.
Kingsmills Is. (V.); Banda (Q., B.); E. Indies (B.).

**A. digitifera* (D.) Brook, p. 75. See notes, below.
E. Indies (D., V.); Madagascar (B.); Gr. Barrier Reef (B.).

**A. dissimilis* Ver. sp. nov. (=*M. echidnæa* D., *non* Ehr.). See notes below.
E. Indies and Sulu Sea (D.).

**A. divaricata* (D.) Brook, p. 64.
Fiji (D.); Seychelles (B.); Gr. Barrier Reef (B.); Amirante Is. (B.).

**A. echinata* (D.) Brook, p. 184.
Fiji (D.); Sulu Sea (B.); Liu Kiu Is. (B.); Samoa (B.); Australia (B.); ? Hawaii (B.), probably imported.

**A. efflorescens* (D.) Brook, p. 35.

Ceylon (D., V., type in Yale Mus.); Fiji (D.); Singapore (B.).

**A. effusa* (D.) Brook, p. 76 (*non* Quelch, t. Brook). See notes, below.

Ceylon (D., V., type in Yale Mus.); Great Barrier Reef (B.).

**A. Ehrenbergii* (E. and H. = *scandens* (Kl., t. Brook) Brook, p. 48. See notes, below.

Red Sea (E. and H., B., V.); Persian Gulf (B.); Indian O. (B.).

**A. erythræa* (Klz.) Brook, p. 157.

Red Sea (Kl.); Mauritius and Maldive Is. (B.); Great Barrier Reef (B.).

A. exigua (D.) Brook, p. 125.

Fiji (D.); New Hebrides and Solomon Is. (B.).

A. exilis (Brook, p. 172, pl. x, C, D).

G. Barrier Reef (B., type); China Sea and Arafura Sea (B.).

**A. florida* (D.) Brook, p. 53.

Fiji (D.); Tongatabu, Malacca, and Louisade Is. (B.).

**A. formosa* (D.) Brook, p. 43.

Fiji (D.); E. Indies (V.); Sumatra, Torres St., Sulu Sea, New Ireland (B.).

**A. Forskalii* (Ehr., Klz.) Brook, p. 70.

Red Sea (Ehr., K., V.); Persian Gulf (B.).

**Acropora fraterna* Ver., sp. nov. (=*M. plantaginea*, *pars*, Br.). See notes, below.

Tahiti (D.).

**A. gemmifera* (Brook, p. 142, pl. xxi), near *A. fruticosa* Br.

Fiji, Torres St., Arafura Sea, and G. Barrier Reef, type, (B.).

**A. globiceps* (D.) Brook, p. 152.

Tahiti (D.).

**A. gracilis* (D.) Brook, p. 32.

Sulu Sea (D.); Fiji, Amboina, and Ceylon (B.).

A. grandis (Brook, p. 42, pl. i, f. A, B).

G. Barrier Reef (B.).

**A. gravida* (D.) Brook, p. 59.

Singapore (D., V.); Fiji and G. Barrier Reef (B.).

A. Haimei (E. and H.) Brook, p. 77 (*non arbuscula* Ver.).

Red Sea (E. and H., B., V.); Ceylon, Mauritius, Maldives, Singapore, and Fiji (B.).

**A. hebes* (D.) Brook, p. 128.

Fiji (D., V., B.); Malacca, Torres St., and G. Barrier Reef (B.).

A. Hemprichii (Ehr., Kl.) Brook, p. 173.

Red Sea (Ehr., K., V., B); Ceylon, Solomon Is., and G. Barrier Reef (B.).

**A. horrida* (D.) Brook, p. 188.

Fiji (D., V.); ? Arafura Sea (B.).

A. humilis (D.) Brook, p. 145.

Fiji (D., B.); G. Barrier Reef (B.).

**A. hyacinthus* (D.) Brook, p. 107.

Fiji (D., V., B.); Tizard Bank and G. Barrier Reef (B.).

A. hydra (Brook, p. 181,=*M. longicyathus* Ort., *non* E. and H., t. Brook).

Singapore (V.).

**A. implicata* (D.) Brook, p. 172.

Fiji (D.).

**A. indurata* Ver., sp. nov. See notes, below

Australia (V.).

A. (*Isopora*) *labrosa* (D., Stud.). See *A. palifera.*

Sulu Sea (D.).

**A. laxa* (Lam., *non* Ehr.) Brook, p. 46, from type

Seychelles, Rodriguez, Macclesfield Bank, and G. Barrier Reef (B.).

**A. longicyathus* (E. and H., *non* Ort.; *non prolixa* V.) Brook, p. 187, from type.

New Guinea (B.); Palau I (V.).

**A. Luzonica* Ver., sp. nov. See notes, below.

Luzon, near Manilla (V.), type in Yale Mus.

**A. microphthalma* (Ver.) Brook, *pars*, p. 168. See *A. parvistella* V., and notes, below.

Loo Choo Is. (V.), type in Yale Mus.

**A. millepora* (Ehr., D., *non* D., t. Brook). Brook, p. 116. See notes below.

Singapore (D., V., B.); Ceylon (D., V., B.); Gr. Barrier Reef (B.).

**A. muricata* (L.), Oken. Brook, pp. 23–30. See pp. 166–169.

*Var. *cervicornis* (Lam.).

*Var. *prolifera* (Lam.).

*Var. *flabello-prolifera* (Ver., p. 167).

*Var. *palmato-prolifera* (Ver., p. 167).

*Var. *surculo-palmata* (Ver., p. 167).

*Var. *cornuta* (D. and M.).

*Var. *flabellum* (Lam.).

*Var. *palmata* (Lam.).

*Var. *perampla* (Horn) V., p. 168,=*M. alces* auth., ? *non* Dana.

*Var. *infundibulum* (Ver., p. 168).

Var. *columnaris* (Ver., p. 168).

*Var. *clivosa* (V.=*cyclopea* Br., *non* Dana).

Florida and the West Indies, to Colon and Cumana.

**A. nasuta* (D.) Brook, p. 73. See notes, below.
Tahiti (D., V., B.); Fiji (B.).

**Acropora neglecta* Ver., sp. nov. See notes, below.
Fiji (Dana).

**A. nobilis* (D.) Brook, p. 135 See notes, below.
Singapore (D., V.); Ceylon (V.); Java (B.).

*Var. *secunda* (D., Ver. from type). ? Brook (*pars*) p. 30.
Singapore (D., V.); Ceylon (B.).

A. ocellata (Klz.) Brook, p. 148.
Red Sea (Kl., V.); Ceylon (B.).

**A. pachycyathus* Ver., sp. nov. See notes, below.
Locality unknown, Indo-Pacific (V.).

A. Pacifica (Brook, p. 89).
Samoa I. (type), and Tizard Bank (B.).

**Acropora paniculata* Ver., sp. nov. See notes, below.
Fiji or Tahiti (V.).

A. parvistella (Ver. 1864 = ? *M. microphthalma* B., *non* Ver.), Brook, p. 107. See notes, below.
Singapore (V.).

**A. paxilligera* (D., *non* Q.) Brook, (*pars*) p. 74.
Tahiti (D., V., B.); Fiji and Mergui Arch. (B.)

A. Pharaonis (E. and H.) Brook, p. 58 = *microcyathus* Kl.
Red Sea (E. and H., B., Kl., V.); Indian O. and Keeling I. (B.).

A. plantaginea (Lam., *non* D., t. Brook) Brook, p. 156.
Tahiti; Samoa, Tongatabu, and Ceylon (B.).

A. pocillifera (Lam., D.) Brook, p. 61, descr. from Lam., type.
Tongatabu (Lam., B.); Tahiti (Q., B.); Fiji (B.); New Hebrides, and G. Barrier Reef (B.).

**A. polymorpha* (Brook), p. 169 = *M. abrotanoides* D., *non* Lam.). See notes, below.
Fiji ? (D.); Malacca (B.).

**A. prolixa* (Ver. *non* = *longicyathus*, as in Brook, p. 187. See notes, below, and figure.
Ousima (V.).

**A. prostrata* (D., *non* Q.) Brook, p. 119.
Sulu Sea (D.); ? Fiji (D., B.); ? G. Barrier Reef (B.).

**A. pumila* (Ver.) Brook, p. 106. See notes, below, and figure.
Bonin Is. (V.).

A. (*Isopora*) *palifera* (Lam., Brook from type, *non* D.) Brook, p. 131 = *M. labrosa* D., t. Brook.
Sulu Sea (D., B.); China Sea, Solomon Is., Diego Garcia, New Guinea, Tizard Bank, Queensland, and G. Barrier Reef (B.).

**A. pyramidalis* (Klz.) Brook, p. 150.
Red Sea (Kl., V., B.); Mauritius, Mergui Arch., Pelew Is., Caroline Is., China Sea, and G. Barrier Reef (B.).

**A. ramiculosa* (D., *non* Q., *nec* Ortm.).
Fiji (D.).

**A. retusa* (D.) Brook, p. 77
Fiji (D., B.); Tahiti (B.).

A. robusta (D.) Brook, p. 42.
Fiji (D., B.).

A. rosacea (Esp., Stud., Q.) Brook, p. 84. See *dissimilis*, and notes, below.
Ternate and Samboangan (Q., B.).

**A. rosaria* (D.) Brook, p. 179.
Fiji (D.); Tahiti; Samoa, Louisade Arch, Caroline Is., Tongatabu, and G. Barrier Reef (B.).

**A. Samoensis* (Brook, p. 143).
Samoa (B., V.).

**A. scandens* (var. of *Ehrenbergii*, t. Brook, p. 40). See notes, below.
Red Sea (Kl., V.).

**A. secale* (Stud., *non* Q.) Brook, *pars*, p. 87,=*M. plantaginea pars*, D, *non* Lam. See notes, below.
Ceylon (D., V.); Singapore? (B.); ?China and Tizard Bank (B.).

**A. secaloides* Ver., sp. nov. See notes, below.
Singapore (D., V.).

**A. secunda* (D., *non* Brook). See under *A. nobilis*, var., and notes, below.
Singapore (D., V.).

**A. (Isopora) securis* (D., *non* Q., t. B.) Brook, p. 133.
E. Indies? (D.); Solomon Is. and Amirante Is. (B.).

**A. seriata* (Ehr., D.) Brook, p. 149=*pallida* and *pyramidalis* (*pars*) Klz., t. Brook.
Red Sea (Ehr., Kl., B.); Mauritius, Mergui Arch., Ceylon, and G. Barrier Reef (B.).

**A. Solanderi* (Def.).
Tertiary of France.

A. spectabilis Brook, op. cit., p. 141, pl. xviii, fig. B.
Locality of type unknown (B.).

**A. spicifera* (D.) Brook, p. 92=*microclados*, *pars*, Ehr., Stud.
Singapore (D., V., B.); Fiji (D., B.); Tahiti (D., V.); Ceylon (D., V., B.); Tizard Bank, China Sea, Gulf of Aden, Mergui Arch., Tongatabu, New Ireland, New Guinea, New Caledonia, and Solomon Is. (B.).

**A. squamosa* (Brook, p. 120, pl. xx, fig. B.). See notes, below.
Singapore (B., V.); G. Barrier Reef (B., type).

A. squarrosa (Ehr.) Brook, p. 65.
Red Sea (E., Kl., B., V.); Pelew I., Ponapé, Tahiti, and Australia (B.).

**A. stellulata* Ver., sp. nov. See notes, below.
Zanzibar (V.).

**A. striata* (Ver.) Brook, p. 178. See notes, below.
Ousima? (V.).

**A. subulata* (D.).
Singapore (D., V., B.); New Guinea (B.).

**A. subtilis* (Klz.) Brook, p. 68.
Red Sea (Kl., V., B.); Solomon Is. (B.).

**A. surculosa* (D.) Brook, p. 104. See notes, below.
Fiji (D., B.); Singapore (D., V., B.); Mergui Arch., and G. Barrier Reef (B.).

**M. symmetrica* (Brook, p. 94, pl. xv). See notes, below.
Mauritius (B., type); Zanzibar (V.).

**A. tenuis* (D.) Brook, p. 83.
Locality of type unknown (D.); Samboangan and G. Barrier Reef (B.).

A. teres (Ver.) Brook, p. 198.
Ousima (V.).

**A. tortuosa* (D.) Brook, p. 71.
Fiji (D.); Caroline Is. (B.).

**A. tubigera* (Horn, *non* Quelch, *nec* Brook, p. 79). See notes, below.
Singapore (V.). Type examined.

**A. tubicinaria* (D.) Brook, p. 139.
Fiji (D.); Tahiti (V.).

**A. tubulosa* (Ehr.) Brook, p. 175.
Red Sea (Ehr., Klz.); New Guinea, Carolina Is., and Malacca (B.).

**A. turbinata* Var.? See *A. surculosa*, and notes, below.
Tahiti (D., type in Yale Mus.).

**A. tumida* (Ver.) Brook, p. 163. See notes, below.
Hong Kong (V.); China (B.).

A. turgida (Ver.) Brook, p. 198.
Loo Choo Is. (V.).

**Acropora urceolifera* Ver., sp. nov. (=*M. corymbosa* D., *non* Lam.).
E. Indies (D.).

A. valida (D.) Brook, p. 168.
Fiji (D., B); Tongatabu, Torres St., Mergui Arch., and Singapore (B.).

**A. variabilis* (Klz.) Brook, p. 161=*coalescens* Ort., t. Br.
Red Sea (Kl., V.); Ceylon, Macclesfield Bank, Samoa, Tongatabu, and G. Barrier Reef (B.).

**A. virgata* (D.) Brook, p. 40.
Fiji (D., B.); Tahiti (B.); New Hanover, Amboina, and Tongatabu (B.).

**A. Wardii* Ver., sp. nov. See notes, below.
Indo-Pacific (V.).

The localities of numerous specimens of species included in the above list, that I have studied, were doubtful or unknown, many of the specimens having been bought from dealers. In such cases I have omitted the doubtful localities, adding only those that seemed to be authentic.

Probably many of the localities given by others, and quoted here, are not altogether reliable, for the same reasons.

Another source of error lies in the various modes of cleaning and bleaching the specimens. Chemicals are sometimes used that injure the delicate parts. Long exposure to the weather, as in bleaching them, always destroys or changes the delicate septa, margins of the calicles, and especially the fine spinules of the surface.

Acropora acervata (Dana) Ver. See p. 212.

Madrepora acervata Dana, Zooph., p. 460, pl. xxxiv, fig 4, 1846. Brook, Cat. Madreporarian Corals British Mus , i, p. 147, 1893.
? *Madrepora amblyclados* Brook, op. cit., p. 140.

PLATE XXXVI. FIGURE 17. PLATE XXXVI B. FIGURE 8.

Brook assumed, without due evidence, that my (1864) determination of Dana's species was incorrect and that I had a distinct species in view. However, I had Dana's types in my hands for comparison, and still have some branches that he specially described, for the details.

Brook merely quotes Dana's description and records no additional specimens. This indicates that he had not identified the species, although it is a common one at Singapore. Doubtless he has it under some other name or names in his catalogue.

Brook was, however, probably correct in stating that Dana's species is not the same as *M. plantaginea* Lam., as described by him

from a specimen supposed to be one of Lamarck's types. But it was probably included under that heterogeneous species by Lamarck and by Edw. and Haime.

This species forms broad convex clumps of rather stout, upright, more or less divided, obtuse branches, with a large, swollen axial corallite. The clumps arise from a broad, short basal mass; the outer and under ones are curved and spread out nearly horizontally in the larger specimens, and they often become flattened, irregular, and more or less coalescent, but they may be much coalescent on one side of a clump and entirely free on the other. In young specimens the outer branches are less spreading, or more upright, and do not coalesce. The central branches of the upper side are mostly 60 to 70^{mm} long, often forked at the base, and may give off two or more small divergent, ascending branches from the middle portion, or distally. The calicles of the horizontal branches and bases of the upright ones are mostly immersed, but rather large and conspicuous, with a very distinct star of six primary septa, the directives larger. Our largest specimen (No. 6118, from Singapore) is a foot in diameter (300^{mm}), and half as high. I have seen others considerably larger, from Singapore.

The axial corallites are large (4^{mm}), very short, obtuse, with very thick, openly porous walls, and a rather small calicle (1^{mm}), which has a distinct star of 12 septa, the directives wider. The lateral calicles are various in size and form. The larger ones are large and thick, tubular, strongly ascending, but not much appressed, with the distal margin obliquely truncate, so that the margin of the calicle is very oblique.

The outer side of these calicles is much thickened and rounded at the outer lip, so that the corallites often appear slightly scaphoid; in some cases they are somewhat appressed, but usually the inner lip is fairly well developed, though much shorter and thinner than the outer. The star is very distinct, usually with 12 septa; the six primaries are wide, the directives broader; those of the second cycle are very narrow and thin, often absent. The exterior wall of these corallites is porous and densely echinulate-costate, the small spinules being arranged in costal lines.

Among the larger corallites are many others that are equally wide, but much shorter, more divergent, the calicles opening more outward, but with a similar thick outer lip and star. Lower down many are verruciform and a few small ones are immersed.

The cœnenchyma of the branches is firm, but somewhat porous,

and covered with sharp or blunt rough spinules, which are not very fine nor very closely arranged; in some places it becomes reticulate-porous.

Singapore (D.; V., type) Several perfect specimens are in the Museum of Yale University (coll Capt. Putnam and others) from Singapore. I have studied others, from the same sources, in the Mus of Comp. Zoology; the Peabody Inst, Salem, Mass.; the Field Columbian Museum, etc. Nos. 1777, 6118, Yale Mus

In mode of growth and general appearance this species resembles *A. Studeri* (Br.); *A. diversa* (Br.), *A. bullata* (Br.); and *A. fruticosa* (Br.), but in the details of the corallites it does not appear to agree very well with either of these.

Acropora appressa (Ehr ?) Dana See p 212

Madrepora appressa Dana, Zooph, p 457, pl xxxi, fig 8, pl xxxiv, fig 5, (? *non* Ehr, t Brook)

Madrepora assimilis Brook, op cit, p. 85, pl xx, fig A

Madrepora alliomorpha Brook, op cit, p 87

? *Madrepora appressa* Ehr, redescribed by Brook from type, op cit, p 87.

PLATE XXXVI D FIGURE 4 PLATE XXXVI E FIGURE 4

Fragments of the type of Dana are in the Yale Museum. No. 2029 Also numerous excellent specimens, of various ages, from Singapore, which agree perfectly with the type. Nos. 1, 3, 5, 6, 8, 11, 1371, 1383, 5541.

When young (up to 100 to 150^{mm} broad), this species does not have the branches of the under side coalescent, or else they are only slightly so. In this stage of growth the branches form a rounded convex clump of much divided branches, arising from a stout basal mass, the outer ones spreading and proliferous. Small branchlets are also given off on the under side and soon begin to be appressed and flattened, losing their prominent calicles. Gradually, as they become more flattened and crowded, they begin to coalesce, openly at first, but eventually, in large specimens, they may form a nearly continuous plate, with few irregular openings through it, toward the margins, as described by Dana.

The immersed calicles of the under side are few, scattered, small (0.5^{mm}), but distinctly stellate, usually with 12 septa, the secondaries narrow.

The fragments from Dana's types apparently came from two specimens. They have the following characters:

The axial corallites are small (1.5 to 2^{mm}), and about 1–2.5^{mm} exsert; walls not swollen, calicle with 12 septa. The radial coral-

lites are mostly strongly appressed and imbricated, seldom arranged serially, but rather in quincunx. The more distal ones are somewhat spreading, mostly compressed, tubo-nariform, the larger ones 4–5^{mm} long, 1.5^{mm} broad, with the aperture very oblique and elliptical; the inner lip may be wanting, or short and thin; the outer lip is elongated, a little thickened, either obtusely rounded or narrowed, usually a little incurved, both laterally and distally. The radial corallites, a little lower down, gradually become more appressed, with the outer lip narrower and more pointed, and the inner lip abortive. The wall of the distal corallites is strongly grooved and costulate, with sharp-edged and finely echinulate costulæ; those lower down have less prominent costulæ, and larger, rough or sharp granules in series; the lower lip is perforate between the costulæ Toward the base of the branchlets the corallites become much shorter, closely appressed, but still tubular, with nearly round calicles. On the larger basal branches there are many immersed calicles, with a very distinct 12-rayed star, and many others with a slightly raised border. These calicles are very distinctly stellate with six wide and six narrow septa, and are 0.75 to 0.8^{mm} in diameter.

All the radial calicles have six strong primary septa, the directives wider, and six narrow secondary ones.

The cœnenchyma is firm, but porous, and roughly echinulate, with rather large, sharp granules, often in series.

The specimens from Singapore agree well with the types in the size and form of the branches and corallites, but the walls of the corallites often lack the costulæ and are densely covered with fine sharp granules, which may be in series; but in most cases the distal and less appressed corallites are more or less costulate, even when those below are evenly echinulate. In some of these specimens the outer lip of the larger radial corallites is thicker and more convex, so that the form is slightly scaphoid.

But in the large series of specimens examined, there are all intermediate states and many other variations.

Hence I am led to doubt the distinctness of *A. appressa* (Ehr.); *A. assimilis* (Br.); and *A. alliomorpha* (Brook), all of which are certainly much alike.

Brook, himself, refers Dana's *appressa* to his *assimilis*, but the general figure of the latter (from a photograph) shows some differences. The most notable is the very evident arrangement of the corallites in vertical series, which I have not observed to any marked extent in the Singapore specimens. The type photographed by him

is from Macclesfield Bank. To me it seems much like *M. alliomorpha* Brook.

The true *appressa* Ehr. has been redescribed by Brook from the type in the Berlin Museum. It has not been figured. It seems to agree pretty closely with Dana's species in most respects, but has larger axial and radial corallites than I have observed in the latter. According to Brook the larger radial ones are up to 8^{mm} long and 2^{mm} thick; the axial 2–2.5^{mm} in diameter. I can find no other marked difference, and possibly this is not beyond the limits of variation in this species, for many others are known to vary more than this in the size of the corallites. The upright branches are shorter than in Dana's type (one inch long, t. Ehr.; 4–6^{cm}, t. Brook).

Brook also states that the wall is "dense and echinulate, not striate." I have shown above that this character is variable in Dana's form. According to Brook the radial corallites are mostly "hooked labellate, with a thick, blunt, and frequently incurved apex." The larger size of the axial corallites (t. Ehr.) formerly led me to suppose that it might be identical with *M. acervata* Dana, but the measurements given by Brook would seem to contradict this, unless the type be undeveloped in this respect; but Ehrenberg states that it is nine inches in diameter.

The distinctions between *assimilis* and *alliomorpha* seem to me very slight and at most only varietal. See also *A. dissimilis*, below.

Acropora arbuscula (Dana) Ver. See p. 218.

Madrepora arbuscula Dana, Zoöph., p. 474, pl. xl, fig. 2, 1846. Brook, op. cit., p. 40.
? *M. laxa* Lam., Brook, p. 46.

This species, in a large series from Singapore, shows much variation. There are two branches of Dana's type from the Sulu Sea, in the Yale Museum (Nos. 2005, 4165) besides a good series from Singapore.

The type differs a little from most of the latter in having the radial corallites rather shorter and more squarrose, with the walls more porous and more distinctly costulate. But these characters vary in this species.

In the type the radial corallites of the upper side of the branch are rather crowded, subequal, short (about 2–3^{mm} long and 2^{mm} broad), tubular, with lower wall a little thicker, obliquely truncate, and with the aperture terminal and a little oblique, owing to the thinner and shorter inner lip. The outer lip is distinctly thickened, rounded, but

not incurved The wall is covered with elevated thin costulæ, which become echinulate lower down, and on the degenerate corallites of the lower side of the branch.

The cœnenchyma is porous-reticulate, or vermiculate-pitted, and sparingly granulated.

The Singapore specimens are variously arborescently branched, with rather few divisions, most of the branches not over 16–20^{mm} thick. The corallites are often few and degenerate on the under side, but generally they are crowded and rather long on the upper side.

The radial corallites stand at various angles, even on different branches of one specimen. Most commonly they are ascending and stand at 45° to 60°, but they may stand at 90°. They are commonly nearly terete, tubular, a little tapered, truncate, with the aperture terminal and often only slightly or not at all oblique, but in other cases decidedly oblique, as in the type. The larger ones are often 4–5^{mm} in length and 2.5^{mm} wide at base. Between these there are usually many short, verruciform, or subconic corallites.

All the calicles are very distinctly stellate, usually with 12 septa, the primaries well developed, with wider directives; the secondaries thin and narrow. The outer wall is generally distinctly thickened, and, the outer lip a little prominent and rounded, but not incurved. Externally the wall of most of the calicles is densely covered with minute granulations, generally in longitudinal lines, but sometimes uniformly arranged, giving the surface a smoothish appearance. On the younger calicles distinct costulæ are often present, but they are seldom so distinct as in the type.

The cœnenchyma is also generally very finely and closely echinulo-granulate, like the corallites, but in many parts it becomes pitted, as in the type.

Some specimens occur in which the corallites of the larger branches and proximal parts of the smaller ones are short-conical or verruciform, with crowded, swollen bases, unequal in size, and in contact, with small, terminal, stellate calicles, 0.5^{mm} in diameter. But on the distal parts of the branches corallites of the ordinary form occur.

This variety has the cœnenchyma and corallites densely echinulo-granulate. It seems to grade into the ordinary varieties, though the small size of the calicles is a striking character.

At first sight the Singapore variety looks like a distinct species, owing to the fine, dense granulation of the surface, and the longer and more tapered corallites. But some of the specimens have

branches showing almost exactly the structure of the type, though other branches may be as usual. Therefore I conclude that the difference is at most only a local variation.

M. laxa Lam., as described from the type by Brook, seems to differ very little from the Singapore variety of this species, and it may, perhaps, be identical. It has not been figured.

Acropora austera (D.) Ver. See p. 218.

Madrepora austera Dana, Zooph., p. 478. Brook, p. 56

PLATE XXXVI FIGURE 10 PLATE XXXVI B. FIGURE 1.

Branches of Dana's type are in the Yale Museum. These show that the axial corallites have thick reticulate walls and 12 wide, thin septa, the 6 primaries nearly meeting. No. 4190.

The radial corallites also have 12 septa, the secondaries narrow.

The walls of the larger corallites are very porous and costulate, but the costulæ are thin and spinulose, and more or less interrupted by the larger pores between them; toward the margin, the walls are often reticulate or fenestrate, owing to the large pores. But the smaller radial corallites often have the walls strongly and roughly echinulate, without costulæ.

The surface of the cœnenchyma is openly porous or reticulate, and very scabrous, with coarse and irregular spinules.

I have seen no specimens, except Dana's type. Brook, apparently, had no specimens of it, unless he put them under some other species, as is not improbable. He refers to it, doubtfully, some worn fragments only.

Acropora dissimilis Ver., sp. nov.

Madrepora echidnæa Dana, Zoöph., p. 458, pl. xxxi, fig. 9, pl. xxxv, fig. 8, 1846, *non* Lam., Ehr , Stud.

Madrepora rosacea Studer (*pars*). Brook, op. cit., p. 84, (*non M. rosea*, as on pl. xv, *nec rosacea* Esper, p. 115).

PLATE XXXVI. FIGURE 9. PLATE XXXVI A. FIGURE 9.

Studer was undoubtedly correct in stating that the *A. echidnæa* (Lam., and of Ehr.) was a very distinct species from Dana's, but he was wrong in uniting the latter with Esper's *M. rosacea*, which has very exsert radial corallites.

Dana's species is closely allied to *cerealis*, *appressa*, and *assimilis*.

It has unequal, tubular, loosely arranged, distal radial corallites; the longer ones but little appressed, and with oblique margins; the calicles open inward and upward.

It has slender, acute, elongated, proliferous branches, with rather small axial corallites, about 3^{mm} in diameter and 1 or 2^{mm} exsert, with porous walls and a small, 12-rayed calicle.

The radial corallites are loosely, irregularly arranged, and very unequal in length. On the distal $25–40^{mm}$ there are many, longer, ascending, tubular corallites, somewhat incurved, not appressed, with the aperture oblique. The larger of these, which are free distally and bear one to several small basal buds, may be 6 to 8^{mm} long and $1.75–2^{mm}$ in diameter; some of them give rise to small ascending proliferous branches.

Between these are other tubular and tubo-nariform radial calicles that are about as large, but not so long, attached for nearly the whole length, but not appressed, or only slightly so, with the aperture oblique, round or slightly elliptical, and directed upward, and without a free inner lip. Part of these are somewhat compressed, with the outer wall thickened and convex; others are nearly round and straight, but all have the outer lip thickened, prominent, obtuse, sometimes slightly incurved, sometimes straight.

The corallites are about $3–5^{mm}$ long and 1.75^{mm} in diameter. Others mixed with these are one-half shorter, with the aperture less oblique. The wall of the distal corallites is echino-costulate; that of the more proximal ones is densely echino-granulate, usually with the granules in series.

On the proximal half of the branches many of the corallites are immersed or have only short appressed lips; on the larger branches they are nearly all immersed, with small stellate calicles.

The radial calicles all have about 12 narrow, unequal septa, the directives a little wider. The cœnenchyma is uneven, pitted, and roughly granulated.

This species is related to *M. alliomorpha* and *M. assimilis* Brook, =*M. appressa* Dana, but seems to be distinguishable on account of its much longer and very unequal radial corallites, which are not so much appressed.

In the length of the radial corallites it is more like the typical *appressa* of Ehr., but that is said to have the corallites strongly appressed and not striate.

As it cannot properly be referred to *A. rosacea* (Esper), I propose to give it, for the present at least, a new name (*A. dissimilis*). Future comparisons with the types may lead to the union of this and several of the allied forms. The union of this and *appressa* (Dana) was suggested by me in 1864, but at present the tendency

seems to be to separate the allied forms of this group, rather than to unite them. Still I think it not unlikely that a larger series of specimens would compel us to unite them in one species.

Acropora diffusa Ver See p 214

Madrepora diffusa Verrill Bull Mus Comp Zool, i, p 41, 1864 Quelch, op cit, p 161 Brook, op cit, p 80

PLATE XXXVI C FIGURE 2 PLATE XXXVI F FIGURE 16

The larger radial corallites in this species are prominent, compressed, nariform, standing at about 45° to 60°, not at all appressed. The outer lip is thickened, a little incurved and considerably longer than the thin inner lip The free part of the inner wall is short but evident, thin The aperture is oblique and elliptical. Six very narrow primary septa are visible; the directives are a little wider than the others. The walls are firm but porous and roughly echinulate; the sharp granules are often in costal lines, but usually no distinct costulæ are visible, unless on very young corallites.

The axial corallites are a little exsert and scarcely larger than the radial, with a small calicle (0 75 to 1^{mm}) The primary septa are well developed, but thin.

Kingsmills Is., cotypes. No 1808

Acropora digitifera (Dana) Ver See p. 214

Madrepora digitifera Dana, Zooph, p 454, 1846 Brook, op cit, p 75, 1893.

PLATE XXXVI FIGURE 12 PLATE XXXVI B FIGURE 3

Several branches of the type-specimen are in the Yale Museum (No. 430). These were, in part, used by Dana in describing the details of the calicles. The longer branches are 50–65^{mm} long, and 10–13^{mm} in diameter at base, somewhat curved and compressed, proliferous, with small normal branchlets on the distal third.

Near the base the calicles are small and many of them are wholly immersed, deep, with 12 very narrow septa; others are larger, with a squarrose, short, thick, spout-like lower lip; the upper lip is abortive, or nearly so.

The most fully formed, radial calicles (2 to 2·2^{mm} in diameter) are on the distal half of the branches; these are large, strongly squarrose, or stand nearly at right angles to the branch. They are spout-shape, rather prominent, with the lower lip thick, expanded, well rounded, and not at all contracted; the upper lip is short and thin. They have a distinct star of 12 septa, all of which are narrow except

the two directives. The outer wall is covered with numerous, very thin costulæ.

The more distal corallites are a little more ascending, but the lower lip is slightly excurved and expanded, so that the calicles are conspicuous. Some smaller immersed calicles (0.3^{mm} in diameter) are found between the labiate ones nearly to the tips of the branches.

The axial corallites are moderately large (2.5 to 3^{mm}), with thick walls, and only a little exsert. The axial calicle is small (1^{mm}), with 12 subequal, thin, but not narrow, septa.

The cœnenchyma of the branches is rather dense, with few small pores, and its surface is covered with rather coarse, rough or sharp spinules, not crowded, and mostly arranged in longitudinal series, or often united into irregular costulæ or small tabulæ.

The origin of the type is unknown, but is doubtless Indo-Pacific.

Acropora effusa (Dana) Ver. See p. 215

Madrepora effusa Dana, Zooph., p. 455, 1846. Brook, p. 76 (*non* Quelch).

PLATE XXXVI. FIGURES 16, 16*a*. PLATE XXXVI B. FIGURES 7, 7*a*.

Dana's unique type of this species from Ceylon (coll. Rev. Geo. H. Apthorp) is in the Museum of Yale University.

It is a regular corymbose clump, with a slightly convex surface, 10 by 14 inches (250×350^{mm}) across, and 5 inches (125^{mm}) high. The upper surface is covered with upright branches 25 to 40^{mm} long, arising from a solid basal mass of cœnenchyma, covered above with immersed stellate calicles. The base is broadly incrusting, about 250^{mm} across, and free marginally only for a slight distance, except on one side, where the free part is 75 to 100^{mm} wide. It here forms a nearly solid plate of coalesced branches, with a few submarginal openings, without free branchlets, but covered thickly with exsert, conoidal, verrucose, and tubular corallites, 1–3^{mm} long, with porous, echinulate walls and 6-rayed, stellate calicles, the directives wider. There are few immersed calicles beneath. The cœnenchyma of the outside base is very porous.

The marginal branches are nearly horizontal at base, and coalescent; submarginal ones are curved upward distally; those nearer the middle are straight, upright, partly simple and partly forked, or more or less proliferous; they are rather stout and tapered, 10 to 15^{mm} thick at base, subacute, with a moderately large, but not swollen, axial corallite, 2.5–3.5^{mm} in diameter, and 1–3^{mm} exsert, with rather thick, openly porous, costulate walls.

Many of the proliferous branches bear rather numerous, large, tubular corallites, mostly with a few small basal buds, some of them thus forming the axial corallites of incipient branchlets, 8 to 12^{mm} long. The gemmiferous corallites are much like the axial, regular tubular, with the calicle terminal, and the walls rather thick and costulate. Septa 12, all narrow, the directives a little wider.

Radial corallites of various sizes intermixed The larger ones are tubular, round or slightly compressed, many of them tubo-nariform; many are dimidiate or spout-shaped; others have the aperture subterminal and oblique. The outer lip is usually prominent, a little thickened, and often slightly incurved, but in others the lip is shorter and straight; many have the inner lip short, or abortive, but in others it is well developed and thin. The smaller intermixed corallites have the same forms but some are short verruciform, others labellate; immersed ones are few, except at the base.

The walls are reticulate-porous and regularly costulate or echinocostulate on the distal corallites, but often evenly and sharply granulated on those of the lower portion of the branches. The basal corallites are mostly short, verruciform, with the calicle terminal. Septa in nearly all cases are 12, but narrow; those of the first cycle are fairly well formed; those of the second are very narrow, sometimes rudimentary; directives are rather wider than others.

The longer tubo-nariform calicles are about 3 to 4^{mm} broad and 2^{mm} in diameter; many of these are gemmiferous at base.

Point Pedro, Ceylon, coll. Rev. G. H. Apthorp, 1843. No. 3003.

This species, in its form and mode of growth, resembles *A. Studeri* (Br.), but the latter forms more regularly corymbose clumps, with shorter and more conical branches, and its corallites seem to be more divaricate and more labiate. *A. bœodactyla* (Br.), pl. xiii, also has a similar form, but the corallites are quite different. It is closely allied to *A. secale* (type from Ceylon).

Acropora indurata Ver., sp nov

PLATE XXXVI. FIGURE 19. PLATE XXXVI C. FIGURE 6.
PLATE XXXVI F. FIGURE 12.

Coral dense and heavy, sparingly branched, with short, stout branches, somewhat as in *A. robusta* Dana. Branches often 25^{mm} or more in diameter, subconic, or gradually tapered, obtuse.

Axial corallites short, scarcely larger than the radial ones and not much different in form; $3-3.5^{mm}$ in diameter, 1 to 2^{mm} exsert; walls

moderately thick and lips rounded; calicle small (about 1^{mm}), with 12 septa distinct.

Radial corallites irregularly arranged, crowded and exsert on the upper side; loosely arranged below, and less exsert; on the smaller branches more regular and ascending, nearly adnate, but not appressed. On the larger branch they stand at angles varying from 30° to 60°, and sometimes form oblique rows. They are verruciform, conoidal, or tubo-conoidal, with thickened walls and swollen base; summit usually obliquely truncated, with the small calicle opening upward; but sometimes it looks downward, or sideways, and often it is terminal.

Length of the larger radial corallites, mostly 3 to 4^{mm}; diameter at base, about 3^{mm}; calicles, 0.75 to 0.80^{mm}.

The distal end of the radial corallites is usually free for 1 to 3^{mm}, with the inner lip well formed, but some are entirely adnate, with no free inner lip. No immersed calicles occur on this specimen.

The radial corallites are strongly stellate; the six primary septa are well developed, but narrow, thick next the wall, subequal; the secondaries are much smaller, but distinct. The whole surface is uniformly and densely covered with fine rough granules.

The type is a single stout branch, 100^{mm} long, with one side branch 20^{mm} long. No. 6155, Mus. Yale Univ. Australia (coll. Ward). The rest of the specimen, on which I made my notes several years ago, may now be in the Field Columbian Museum, Chicago.

This species is remarkable for the unusual density of its cœnenchyma, and for its conoidal radial corallites.

Acropora Luzonica Ver., sp nov.

PLATE XXXVI C. FIGURE 4   PLATE XXXVI F. FIGURE 9.

Coral arborescent, distantly, loosely, and irregularly branched, with the branches often forked, mostly ascending, but some are widely divergent and often crooked. The terminal branchlets taper gradually to rather slender tips. Principal branches are mostly 12 to 15^{mm} in diameter at base; terminal ones are 6 to 10^{mm} thick at base, and up to 60 to 75^{mm} long. Their tips are subacute, truncate, with the axial corallite 2 to 3^{mm} in diameter and 1 to 3^{mm} exsert, walls are not very thick, reticulate-porous, and strongly costulate.

The radial corallites are mostly entirely or nearly immersed, on all the larger branches; some of them have slightly raised, thin margins; others have the lower lip a little prominent; their calicles

are rather large (1 to 1·25^{mm}), and regularly stellate, with six well-developed primary septa and six narrow ones; the directives nearly meet in the center.

On the more distal parts, and especially on the terminal branches, the margins of the calicles become more elevated, especially on the lower side, forming thin lower lips that stand out often nearly at right angles, but unevenly so, thus giving the surface a rough and irregular appearance

Those near the ends of the branches are often tubular, but entirely adnate, with the large, terminal, round calicles opening upward; the inner lip being thin and very short or adherent, while the thin outer lip is tubular and truncate. A little lower down the inner lip is suppressed and the outer lip is shorter and often half-tubular or dimidiate, but the calicles are nearly round and often open rather outward, so that they are conspicuous in a side view. They are rather crowded and unequal in size, the larger ones being about 1.25^{mm} in diameter. All the larger ones have 12 septa, but the septa may all be rather narrow, except the directives, which are usually well developed.

The walls are always thin, compact, and strongly costulate. The cœnenchyma is firm but porous, irregularly pitted, and covered with rather loosely arranged, small, rough granules.

Manilla Bay, Luzon. The type is in the Mus. Yale Univ. (No. 1809, orig. number 198), received from the Museum of Comp. Zoölogy, where there were formerly many specimens.

This species belongs to the subgenus *Eumadrepora* of Brook. It is, perhaps, more nearly allied to *Acropora pulchra*, var. *stricta* Brook, than to any other form described by him, but the latter has smaller and more tubular corallites, and the surface is "closely reticulate."

Acropora microphthalma Ver See p 216

Madrepora microphthalma Verrill, Comm Essex Inst., vi, pp. 83, 102, [49, 68,] 1869 Brook (*pars*), p 168

PLATE XXXVI C. FIGURE 1 PLATE XXXVI F. FIGURE 15.

The specimens referred to this species by Brook (p. 169) appear to be quite distinct. They are "laxly arborescent; branches elongate, 2^{cm} thick; scarcely tapering," and have much larger radial corallites, which are "dilated, tubular," with the inner part of the wall "often incomplete or absent."

None of these characters apply to my original type, which is in the Yale Museum (No. 774). This is a very much branched, small, arborescent coral, with the branches small (larger ones about 10^{mm}), strongly divaricate, and very proliferous, especially distally. Many of the smaller branchlets stand nearly at right angles to the branches; others at 45° or less.

The axial corallites are small (1.75 to 2^{mm}), not swollen, a little exsert, slightly tapered, with the wall porous and finely echinulate, rarely echino-costulate.

The radial corallites are very unequal in size and form, but all are small. The larger ones (1.5–2^{mm}) are nearly regularly tubular, a little tapered distally, obtuse at the end (about 3^{mm} long), with the calicle small and only slightly, if at all, oblique, and about 0.5 to 0.6^{mm} broad, with thickened walls. The six septa nearly meet in the center; rudimentary ones of the second cycle are often present, but minute. These larger corallites mostly diverge at an angle of 45° or more, except distally.

Between the larger ones are many smaller subconical or verruciform corallites, standing at various angles, with the terminal calicles only 0.3 to 0.4^{mm} in diameter, while others, like small, rounded verrucæ, have calicles of only 0.2^{mm} diameter, but yet show six septa.

The corallites and cœnenchyma are densely covered with minute sharp granules, and show but few pores.

The type of *A. microphthalma* was from the Loo Choo Islands.

The specimens described by Brook were from Korea, Torres St., and Ramesvaren. They may, perhaps, belong to *A. parvistella* (Ver., 1864).

Acropora nobilis (Dana) Ver. See p 217

Madrepora nobilis Dana, Zooph., p. 481, pl. vi, fig. 8, 1846, × *M. secunda*, var., p. 481, pl. xi, fig. 4. Verrill, Bull. Mus. Comp. Zool., i, p. 40, 1864.

A good Ceylon specimen (No. 454) of this species, which was used by Dana in his description, is in the Yale Museum, and also a branch of his East Indian (Singapore) type. Also, one of his types of *M. secunda*, from Singapore (No. 2014).

In addition to these, there are numerous good specimens of this species from Singapore (coll. Capt. W. H. A. Putnam and others). I have also seen large series in other museums.

The Ceylon specimen is a low clump of short, stout branches, up to 25–30^{mm} in diameter, arising from a large basal mass. The branches divide rapidly and irregularly, so that the undivided termi-

nal branches are mostly only 25 to 50^{mm} long, and taper rapidly. They stand at various angles ; some are almost squarrose.

Most specimens grow taller (up to 2 feet high=600^{mm}) and branch more arborescently, with longer and more distant branches, variable in size. This was the case with Dana's Singapore type.

But the characters of the corallites are generally pretty constant in all. The axial corallites are nearly always large and swollen, with thick, porous walls; their diameter is commonly 4 to 5^{mm}, but varies from 3 to 6^{mm} on a single specimen; their calicles are about 2^{mm} broad ; the naked, exsert portion may be 2–3^{mm} in length.

The radial corallites are various in size and form on one branch. The larger ones, in typical *nobilis*, are dimidiate-cylindrical or spout-like, scarcely at all compressed, with the lower lip thick and rounded, rather long, porous, often slightly expanded, frequently a little incurved, but distally on the branches more spreading and often a little excurved, though the greater number are nearly straight on the outer side; they stand at angles of 50° to 90°, but more generally at 60° to 70°. The inner lip is usually short and thin. The larger ones are usually about 2–2.5^{mm} broad and 2 to 4^{mm} long.

Their septa are very distinctly stellate, with six rather wide primary septa, the directives wider, and six narrow ones of the second cycle. The axial corallites have 12 distinct septa, rarely 24.

The walls of the axial and radial corallites are strongly costulate, with pores between the costulæ ; the lower lip of the radial corallites is fenestrate-porous distally. The cœnenchyma is very porous and pitted, and roughly granulated.

Between the larger radial corallites there are many small labellate or dimidiate ones, with the outer lip either long or short, straight or incurved, and also a few that are nearly or quite immersed.

Var. **secunda** Ver , 1864

Madrepora secunda Dana, op. cit., p. 487, pl. xl, fig 4.

One of Dana's types of this form, in the Yale Museum, forms a loosely, arborescently branched clump, about 10 inches high (250^{mm}), with the main branches rather long and divergent, about 15 to 18^{mm} in diameter, branching freely distally, with evenly tapered branches.

In its form and mode of branching it does not differ from many typical specimens of *nobilis*, but the main branches are more slender than usual.

The terminal or axial corallites are thick and swollen, porous, and costulate, formed exactly as in *nobilis*, though they average rather

smaller, but several of the branches have them as large as is usual in typical *nobilis;* they vary from 3 to 5^{mm}, the average being about 3·5 to 4^{mm}.

The structures of the cœnenchyma and walls are as in *nobilis.*

The lateral corallites are rather smaller than usual in that form, and they are mostly distinctly compressed, and have the outer lip less thickened, and more often incurved, so that many of the corallites are slightly boat-shaped, and the calicles elliptical; but they are cut away on the upper side and have the short inner lip as in *nobilis.*

Moreover, on some branches of the type, the calicles are not more compressed than often occurs on typical *nobilis.* This character varies in this species, as in many others, and may be due to more or less crowding of the buds.

This more compressed and more beaked form of the radial calicles is, however, the only tangible character for separating this form, even as a variety.

The second condition, due to the partial suppression of the corallites on the under sides of some branches, is an accident of growth that may occur in any species. The smaller size of the branches is not even of varietal importance.

Brook not only considers *secunda* a good species, but he puts it in a different group,* far removed from *nobilis*, though he refers to my uniting these forms in 1864. Probably Brook had a different species, from Australia,† which he described under the name of *secunda;* but he also quotes Dana's description.

My conclusion in regard to this point, in 1864, was based on a *direct comparison of Dana's types* of both forms, with a fine series of *nobilis* in the Mus. of Comp. Zoology. Although I have studied larger collections since then, I have seen no reason to change my opinion.

* Brook puts *secunda* in his 1st subgenus, *Eumadrepora*, on p 80, *nobilis* in his 6th subgenus, *Tylopora*, on p 185 This is mainly an account of the slight difference in the size of the axial corallites

† Brook's Australian specimen is said to have the radial calicles rather distant, much compressed, thin-walled, tubo-nariform or dimidiate, 3–4.5^{mm} long, 1.2–1.6^{mm} broad; the walls striato-reticulate, not echinulate, unless at base. Most of these characters do not apply to Dana's *secunda*, especially the thin-walled, elongated, nariform corallites, nor would Dana's species go in the subgenus *Eumadrepora*, as defined.

Hence I believe it a distinct species with a superficial resemblance to *secunda* and would propose to call it *secundella*, sp nov. The types are from Port Denison and Bandin Is., Australia (coll. Kent).

Even in 1864, I had devoted over three years to the continuous study of reef-corals, including all of Dana's types, so that I was then very familiar with all his species, and not more likely to err than now, in comparing types.

A. canalis Quelch, sp. (op. cit., p. 150, pl. ix, fig. 2), from the Philippines, is a very closely allied species, and perhaps will not prove to be distinct, when a series from that locality can be studied.

Brook refers the latter (with *nobilis*) to his subgenus *Tylopora*, on account of the large, thick-walled axial corallites. This character is as variable as others, and I think that Brook has given it too much importance in many cases, thus widely separating species that are closely allied, and perhaps, in some instances, widely separating forms that are mere varieties of a single species, as in the case of *secunda* and *nobilis*. To me this species seems to be more nearly allied to typical *Eumadrepora*

Acropora pachycyathus Ver., sp. nov.

Plate XXXVI Figure 20 Plate XXXVI C Figure 5.
Plate XXXVI F Figure 6.

Coral probably cæspitose, perhaps corymbose. Branches divergent, stout, 20–25^{mm} in diameter, often irregularly proliferous; the terminal branchlets short, tapered, obtuse.

Axial corallites large and swollen, (4–5^{mm} in diameter), with thick, rounded, porous walls and a rather large, deep calicle, 2^{mm} in diameter. They are about 2–4^{mm} exsert.

Radial corallites large, thick, unequal in size, ascending, laterally sessile, very irregularly arranged, often aggregated into uneven and prominent clusters. The larger ones are mostly tubular, or conic-tubular, with stout, enlarged bases and thick, swollen, incurved summits; their small calicles open obliquely inward, so as not to be visible in a side view. But with these are some that are more regularly tubular, truncate at the blunt ends, with the calicle round and terminal; some of these may carry basal buds and eventually become axial corallites. They are from 3 to 5^{mm} long and 3 to 3.5^{mm} in diameter. They are mostly attached for the whole length of the inner side, but not appressed. The inner lip is usually very short or absent, but may be fairly well developed. The aperture is very small (0.6 to 1^{mm}) and often is almost concealed by the very thick, rounded outer lip, which usually curves inward very strongly. On the distal part of the branchlets they are more regular in form and

arrangement, with the end truncate and the nearly round calicle opening upward.

Among the larger radial calicles are many that are smaller, shorter, conoidal or verruciform, with a very small terminal calicle, often less than 0.5^{mm} in diameter. No entirely immersed calicles occur on these branches.

Septa of the axial corallites 12, those of the 1st cycle well developed, the others narrower. In the radial corallites six are wide and six very narrow, but distinct.

Surface of walls and cœnenchyma everywhere rather coarsely and roughly echinulate; the granules on the distal corallites usually thorny or lacerate, not crowded, often in costal lines, but no costulæ are visible. The cœnenchyma is dense.

The type (No. 6141) is a single branch with four principal divisions and several small, distal, divergent branchlets.

Locality unknown (coll. Ward). Perhaps the rest of the specimen may be in the Field Columbian Museum.

This species is remarkable for the large, very thick-walled, closely adherent radial calicles, having the small apertures mostly concealed in a side view, by the very swollen, incurved outer lip.

It belongs to the group *Tylostoma*, in Brook's system, on account of the large and swollen axial corallites, but it does not have much resemblance to any other species of that group. Perhaps, in general appearance, it is more like *A. gonagra* than any other species.

Acropora prolixa Ver. See p. 217

Madrepora prolixa Ver., Communications Essex Inst., Salem, vol. v, p. 22, 1866. Brook, op. cit., p. 187.

PLATE XXXVI. FIGURES 3, 3*a*. PLATE XXXVI A. FIGURES 3, 3*a*.
PLATE XXXVI F. FIGURE 14.

Mr. Brook (p. 187) referred this species doubtfully to his *M. longicyathus* (E. & H.), which he redescribed from the type.

Our species does not agree with his description, nor with an authentic fragment of the type of Edw. & Haime, sent to the Mus. of Comp. Zoölogy, by Prof. Milne-Edwards himself, and with which I had compared my type, in 1864, as then stated.*

* Mr. Brook, in numerous instances, ignored the fact that I have had constant access to the types of Dana and others and that my determinations of species were made by comparison with types. Thus he often arrived at different and erroneous results. Had he kept this fact in mind, and given it due weight, he might have avoided several errors.

I will add the following details from one of my types:

The cœnenchyma is very finely and evenly echinulated, and almost without visible pores.

The radial corallites are mostly short, verruciform, but some are long, tubular, tapering from a thickened base; there are also many small immersed calicles. The radial calicles are all small, but they mostly have 12 septa, those of the second cycle being very narrow; those of the first cycle meet below, as seen in sections.

Wall of the axial calicles is thickened and rounded at the margin; the sides are without costæ. In sections the wall is thick and nearly solid, and the cœnenchyma is dense.

Ousima. No. 1686.

It is nearer *A. procumbens* (Br., p. 188, pl. xxviii) than to *longicyathus*. It also resembles, in a general way, *A. subglabra* (Br.), and *A. Rayneri* (Br.).

Acropora stellulata Ver., sp. nov.

PLATE XXXVI C. FIGURE 8 PLATE XXXVI F. FIGURE 10

Coral arborescent, loosely and sparingly branched, with long slowly and regularly tapered, terete branches, which often diverge at an angle of 50° to 60°. The larger branches are 12 to 14^{mm} in diameter, or more; the undivided distal ones may be 70 to 100^{mm} long, and 10^{mm} in diameter, 70^{mm} from the end.

The axial corallites are of moderate size (2 to 2.5^{mm}), cylindrical, a little exsert, with somewhat thickened porous, strongly costulate walls, bearing small buds close to the end; the costulæ are regular, thin, and high.

The radial corallites are small, tubular, squarrose, short and standing nearly at right angles on the larger branches, but becoming longer and slightly ascending more distally. The larger ones on the distal half of the terminal branches are longer than broad (about 1^{mm} broad and 2^{mm} high), slightly or not at all compressed, not tapered, obliquely truncate, with the outer lip rounded, a little thickened, and slightly incurved; the inner lip thin. Their walls are porous, sometimes reticulate-porous, and strongly costulate, with thin, high costulæ. Between these are scattered many smaller, short, tubular corallites, mostly squarrose and with reticulate walls.

On the larger branches the corallites are of more uniform size and length, very squarrose, short tubular or sub-verruciform, not so high as broad (diameter about 1^{mm}), with the calicle terminal and about 0.5 broad. Wholly immersed corallites seldom appear, except a few on the under side of a single injured branch.

Six septa are well developed and form a regular star in all the calicles, the directives being wider. In many calicles six very narrow septa of the second cycle are visible.

The cœnenchyma is dense and rather closely covered with rather sharp rough granules, often united into linear or irregular groups, and also more or less covering the walls of the corallites on the larger branches.

Zanzibar, Mus. Yale Univ., type, No. 485. Received from Boston Soc. Nat. History, as a duplicate.

This species somewhat resembles *A. virgata* (D.), the type of which (No. 2001) I have compared with this. *A. virgata* has the larger radial corallites stouter, more ascending, more compressed, obliquely truncated, with a very short inner lip, and more strongly costulate and echinulate walls. The corallites of the larger branches are larger, less squarrose, more prominent. Its cœnenchyma is more strongly and more roughly spinulose.

Acropora tubigera (Horn) See p 219.

Madrepora tubigera Horn, Proc Acad. Nat. Sci , Philad., 1860, p 485 (*non* Quelch, *nec* Brook).

PLATE XXXVI. FIGURES 1, 2–2*b*. PLATE XXXVI A. FIGURES 1, 2, 2*a*, 2*b*. PLATE XXXVI F. FIGURE 8.

Horn's type, in the Mus. Phil. Acad. of Science, was carefully examined by me, many years ago, and described in my notes. Several fine specimens now in the Museum of Yale University and Mus. Comp. Zoölogy, from Singapore, were identified by me, at that time (1863), by direct comparison with the type.

It is a common Singapore species. Many specimens were brought from there about 1860 to 1863, by Capt. W. H. A. Putnam, during several voyages to that port. These are now in the Museum of Comp. Zoölogy; the Peabody Inst., Salem, Mass.; and the Yale Museum. Altogether I have seen about 20 specimens of it.

It forms somewhat irregular rounded or one-sided, much branched, convex clumps, up to 12 to 15 inches (300–375^{mm}) across, and 4 to 8 inches (100–200^{mm}) or more in height, with the proliferous terminal, upright branchlets rather slender, tapered, subacute, and usually terminated by a slender exsert axial corallite.

The texture of the coral is firm, dense, almost translucent, with few pores, and the surface of the cœnenchyma is generally vermiculated or irregularly pitted, sometimes costulate, and rough with more or less numerous spinulose granules.

The main branches spread out radially from the stout, one-sided or subcentral base, and branch dichotomously; the outer branches lie nearly in one plane, but usually do not coalesce to any considerable extent.

The under side is covered with short irregular branchlets, directed outwardly, and somewhat appressed, each having one or several long divergent, often crooked and tapered tubular axial corallites, up to 10 to 15^{mm} long, and 2 to 2.5^{mm} in diameter. Many of these tubular corallites stand separately, or in clusters of 2 or 3, without any radial corallites upon them; but most bear at least a few small, appressed radial corallites, and many terminate the small, irregular branchlets.

The immersed corallites of the under side are scattered, not very small, and have a conspicuous star.

The cœnenchyma beneath is very firm and dense, translucent, and with a strongly vermiculated, rough surface, in many places sharply granulated.

The ascending branches and branchlets of the upper side are much subdivided dichotomously, the divisions forming acute angles; those toward the margins are often very proliferous. The smaller simple branches are from 5 to 8^{mm} in diameter, and up to $20–25^{mm}$ long; usually evenly tapered and acute.

The axial corallites are slender (1.7 to 2^{mm} thick), cylindrical, and usually considerably exsert (up to $4–6^{mm}$, rarely 10^{mm}); the wall is moderately thick and very strong, though perforate, not swollen at the margin; its exterior is covered with regular and rather thin costulæ, between which there are rows of pores, in the grooves.

The radial corallites are rather large, especially on the larger branches, where they are nearly immersed; the distal radial calicles are about as large as the axial, or even larger. The distal radial corallites are short and rather openly tubular, with the summit very obliquely truncate, so that the inner lip is abortive, or nearly so; the outer lip is large, thin, often fenestrate, frequently a little narrowed and incurved at the tip, but often flaring somewhat. These corallites stand at angles of 30 to 45°, and are not appressed; they are about 2.75 to 3^{mm} long, and about 2.5^{mm} broad. The wall is thin, porous distally, and covered with regular, sharply defined costæ.

The calicles are all distinctly stellate; the radial ones have six strong primary septa, the directives widest, and usually six very narrow secondary ones. The axial corallites have six wide and subequal septa, usually with six very narrow ones of the second cycle.

On the proximal part of the branches some of the corallites are

low, verruciform, and broad at base; others are immersed, not crowded, separated by coarsely and roughly echinulate and irregularly pitted, dense cœnenchyma; the calicles are large and their 12 septa are distinct and nearly equal.

Singapore (coll. Capt. Putnam). Nos. 1370, *a*, *b*, *c*, *d*, etc., No. 1483, fragment of type.

Acropora Bandensis Ver., nom. nov.

Madrepora tubigera Quelch, op. cit., p. 161. Brook, p. 79, (*non* Horn.)

Probably the specimens described by Quelch and by Brook, from Banda, as *M. tubigera* were not of this species, for they say that it has a very porous cœnenchyma ("extremely porous," Brook), while in the type and in all our Singapore specimens it is remarkable for its density and hardness.

Brook also states that in the radial calicles the septa of the second cycle are "usually not noticeable," which is contrary to the condition in this species. The axial corallites are also said to be labellate or nariform. Therefore I propose to designate the Banda form as *A. Bandensis*, with the diagnosis as given by Brook.

Acropora tumida Verrill.

Madrepora tumida Verrill, Synopsis Polyps and Corals North Pacific Expl. Exp., Comm. Essex Inst., v, p. 21, 1866. Brook, op. cit., p. 163.

PLATE XXXVI. FIGURES 11–11*b*. PLATE XXXVI B. FIGURES 2, 2*a*, 2*b*. PLATE XXXVI F. FIGURE 3.

This species is easily recognized by the evenness of the under surface of the partially coalesced branches, with very small immersed calicles, and by the short, swollen, thick-lipped corallites of the upper surface of the larger branches.

On the distal parts of the upright branchlets the tumid character of the radial corallites is not so marked, and they are directed more upward, or may become somewhat appressed, but they are thick at the base, and taper to the summit, with the end rather squarely truncated and the terminal calicle opening upward.

The walls are echinulo-costulate, or sharply echinulate, with the acute granules arranged in lines, and with very few pores. There are six well developed septa, and often four to six rudimentary ones.

The axial corallite is a little exsert, rather stout (2.5 to 3^{mm}) with thick walls and a small calicle with six subequal primary septa and six small secondary ones. The calicle is not larger than that of the radial corallites (about 1^{mm}).

A fragment of the original type, from near Hong Kong, is in the Yale Museum, No. 886. The rest is in the U. S. Nat. Mus.

A. glauca (Brook) is evidently closely related to this species, and very likely may be identical with it.

Acropora turbinata (Dana) Ver

Madrepora surculosa, var *turbinata* Dana, Zooph., p. 446, pl. xxxii, fig. 5, 1846. Brook, op. cit., p. 200, 1893.

Madrepora turbinata Verrill, Bull. Mus. Comp. Zool., i, p. 42, 1864.

? *Madrepora armata* Brook, 1892; Brook, Catal., p. 100, pl. x, figs. A. B

Plate XXXVI. Figure 6. Plate XXXVI A. Figure 6.
Plate XXXVI F. Figure 2.

The type of this form, which Dana considered a marked variety of *surculosa*, is in the Museum of Yale University, No. 2017.

It appears to be a species quite distinct from Dana's type of *M. surculosa*, from the Fiji Islands, fragments of which are also in the Yale Museum, No. 4181.

This coral forms a somewhat turbinate corymbose, nearly flat clump, consisting of stout, divergent, ascending primary branches, arising from an incrusting base and rarely coalescent. The exterior surfaces of the outer branches, from the base up, are covered with numerous, small, irregular, divergent, proliferous branches, not at all appressed, which give the under side a rough, ragged appearance. These mostly vary in length from 10 to 40^{mm}, the upper ones longer; the proliferous ones may bear branchlets 6–12^{mm} long and 4–6^{mm} in diameter, with slender exsert axial corallites, 1.5 to 3.5^{mm} long, and tubular, truncate, or labiate-tubular radial corallites, with the aperture either terminal or oblique. On the lower branches are numerous immersed corallites, about 1^{mm} in diameter, with rudimentary or abortive septa, as in *surculosa*.

The upper side is covered with rather slender, neatly tapered, acute, forked or proliferous upright branchlets, their divisions rising at an acute angle, and nearly parallel, as is well shown in Dana's general figure of this specimen. Some of them bear 6 to 10 divisions. The larger branchlets are 35 to 50^{mm} long, often 8 to 10^{mm} thick at base, when simple or nearly so; those toward the margins are compressed and stouter.

Axial corallites are rather small and slender, about 2^{mm} in diameter and 1–2^{mm} exsert; walls thin, reticulate-porous, strongly costulate; septa six, narrow, the directives usually a little wider.

Radial corallites small, prominent, regularly arranged, not crowded, strongly divergent, mostly at angles of 60° to 70°, openly tubular, with the aperture oblique and looking upward, not compressed, nor appressed, inner lip adnate or abortive; outer lip prominent, narrowed distally, concave, slightly or not at all incurved, very thin, fragile, reticulate-porous, regularly costulate, with thin costulæ. Calicles relatively large and open; septa nearly all abortive or rudimentary; sometimes the directives alone are visible and very narrow.

Below the middle of the branchlets and on the basal branches are numerous immersed calicles, 0·75 to 1^{mm} in diameter, with rudimentary or abortive septa.

Cœnenchyma very openly porous and pitted, or vermiculate, and sometimes lamellose at the surface.

Tahiti, J. D. Dana (coll. U. S. Expl. Exped.). Yale Mus., No. 2017.

This species is closely allied to *A. surculosa* (typical), and apparently to *A. corymbosa*, as restricted by Brook. Compared with a branch of Dana's type of *surculosa* from the Fiji Islands (Yale Mus., No. 4181), the latter has much more compact cœnenchyma, echinulate in series at the surface; the radial corallites are shorter with a broader, more dimidiate, and flatter outer lip, which is also firmer, much less porous, and more truncate, with more strongly costulate walls; the calicles are still more widely open, but have the same sort of rudimentary septa. The rather large, open, immersed calicles are also essentially the same, with rudimentary or abortive septa, but they are perhaps a little larger ($1–1.20^{mm}$).

Perhaps, with a large series, we might be obliged to reunite the two forms, but with the specimens that I have hitherto seen they seem to be as distinct as many of the recognized species of corymbose *Acroporæ*. Should we unite these species, it would probably be necessary to unite with them, also, *M. corymbosa* (Brook), *M. cytherea* Dana, *M. symmetrica* Brook, and others of the same group, in which the radial and immersed calicles are not stellate, but have only rudimentary septa. See below under *A. symmetrica*, p. 254, and *cytherella*, p. 253.

I cannot perceive any appreciable specific differences between this species and *A. armata* (Brook), as described and figured by Brook (see below, p. 252), and think that they should probably be united.

Acropora secale (Stud.) Ver. See p. 218.

Madrepora plantaginea Dana, Zooph., p. 459, 1846 (*non* Lam.).
Madrepora secale Studer, Reise Corv Gazelle. Monatsb. Kongl. Preuss. Akad. Wissens., Berlin, 1879, p. 580 (*non* Brook, p. 88, 1889).
Madrepora Ceylonica Ortmann + *M. remota* Ort. + *M. valida* Ort. + *M. secale* Ort., Zoöl. Jahr., 1889, iv, pp 506, 510, pl. xiii, fig 6; pl. xli, fig. 8.
M. Ceylonica Brook, op. cit., p. 162.

PLATE XXXVI. FIGURES 14, 14*a*. PLATE XXXVI B. FIGURES 5, 5*a*.

The large specimen from Ceylon, described by Dana, which is distinct from his Singapore specimens, is in the Yale Museum (coll. G. H. Apthorp). This is a crescent-shaped corymbose clump, attached by a large, one-sided pedicel. It is about 2 feet long and 1 foot broad, with the upper surface a little convex, the length of the upright branches decreasing from 75–85^{mm} in the middle to 25 to 40^{mm} near the border, while the under side is inclined upward. The main branches are completely coalesced, so that the under side is a nearly even, thick plate, without any projections and with scarcely any openings, except close to the margin, where the branches are reticulately joined; the immersed calicles of the under side are scattered, small, six-rayed.

The upright branches of the upper side are rather stout (mostly 10 to 15^{mm}), obtuse, somewhat angular, sparingly proliferous, except the marginal ones. They are rather close, mostly separated by intervals of 12 to 20^{mm}.

The axial corallites are rather thick and swollen, rounded, little exsert, with a small calicle and thick, porous walls; diameter, about 3–3.5^{mm}; calicle, about 1^{mm}. The calicle has 12 thin, narrow, subequal septa; wall closely and finely echino-granulate, in series.

The radial corallites are very unequal in size and form. The larger ones, which are mostly on the distal part of the branches, and within 25–35^{mm} of the tip, are large, tubular, a little tapered, with thick walls, rounded at tip, and with a small terminal calicle. Many of these have a few small, radial calicles on their basal portion, and are then like incipient branches. They are 3–6^{mm} exsert; diameter about 2.5–3^{mm}.

Between these, with some nearly or quite immersed calicles, are also many short (1–2.5^{mm}), thick, ascending or appressed, tubular corallites, with the outer lip thick, rounded, and often a little incurved, and the calicle oblique and slightly elliptical; the inner lip is short and thin, or often abortive. Wall densely and finely granulated, with sharp granules arranged in costal striæ.

Some of the radial corallites are longer (2–3mm), with the outer surface convex, or boat-shaped, and the calicle opening obliquely inward. The radial corallites have six narrow primary septa, the directives rather wider when the calicle is elliptical; often 4 to 6 rudimentary septa of the second cycle are also visible.

Point Pedro, Ceylon, 1843 (Rev'd Geo. H. Apthorp), No. 3063. (See note, p. 210.)

This is the type-specimen on which Dana based his description of *M. plantaginea.* It, therefore, becomes also the type of *M. secale* Studer. Studer's *M. secale* was simply a new name for Dana's *plantaginea.* He gave no description. According to Brook (p. 88), Studer's specimens in the Berlin Museum include more than one species. He gave Singapore as the locality of his specimens. Therefore he probably had in mind an East Indian form, rather than the one from Ceylon. However that may be, Dana's type, from Ceylon, in the Yale Museum, was the one that he described.

The species described as *M. Ceylonica* by Ortmann, and by Brook, with the other related forms described by Ortmann, from Ceylon, appear to be varieties and different stages of growth of this species.

The specimens described by Brook, as *M. secale*, are probably a different species, and more like *A. appressa* (Dana).

In mode of growth this species resembles *A. leptocyathus* (Br.), and also *A. Guppyi* (Br.). It may prove to be only a variety of *A. effusa* (Dana), to which it is very closely related.

The specimens from Singapore, mentioned but not described by Dana, are quite distinct, with smaller upright branches; those of the lower side not forming a plate; axial corallites smaller; radial corallites short and swollen. One of these types is in the Yale Mus. (No. 2033). It is not *M. secale* of Brook. I have described it below under the name of *A. secaloides.*

Acropora secaloides Ver., sp. nov.

Madrepora plantaginea (*pars*) Dana, Zoöph., p. 459, (*non* Lam., *t* Brook).
Madrepora secale (*pars*) auth., (*non* Studer)

PLATE XXXVI. FIGURES 15, 15*a*. PLATE XXXVI B. FIGURES 6, 6*a*

One of the specimens that Dana named *M. plantaginea*, now in the Yale Museum, is quite distinct from the Ceylon specimen, on which his description was evidently based, and which has thus become the type of *A. secale* (Studer), see p. 244. The specimen referred to is from Singapore and apparently belongs to a species

that has not yet received a distinctive name, hence I propose to call it *A. secaloides.*

It is a flat-topped corymbose clump, about 18x15 inches across (450x375^{mm}), and five inches (125^{mm}) thick. It arises from a stout, short, pedicellate base. The nearly horizontal primary branches coalesce into a nearly solid plate subcentrally, but farther out there are many irregular openings, and numerous flattened, obtuse, appressed branchlets, with only a few small, immersed calicles, the surface in general appearing rather smooth, as if covered with plaster of Paris.

The upper side is covered with nearly upright, moderately stout dichotomous branches, mostly 12–18^{mm} in diameter at base. Those of the central parts are 75 to 100^{mm} long. They may fork two or three times; most often they divide near the base into two or three ascending branches, and these again divide into 2 to 8 terminal branchlets, 25 to 50^{mm} long. Some of them may be proliferous near the tip; they are mostly 8 to 10^{mm} in diameter, little tapered, obtuse.

The axial corallites are of moderate size, 2.5–3.5^{mm}, usually about 3^{mm} in diameter, and 1–2^{mm} exsert, with the walls rather thick, compact, and finely, evenly echinulate-granulate, not at all costulate; calicle small, with 12 unequal septa.

The larger radial corallites are short, divergent, with very thick, prominent, rounded outer lip, not appressed; inner lip usually wholly adnate; calicles, rather small, .07–.08^{mm}, conspicuously stellate, opening upward, little visible in a side view; primary septa well developed, secondaries narrower, but very distinct. Walls thick, compact, very evenly and finely echinulate-granulate, like the cœnenchyma.

Between the larger radial corallites there are many smaller ones, often verruciform, with short lips, and some wholly immersed. On the proximal third of the branches most of the calicles are immersed, but stellate with 12 septa. Cœnenchyma rather compact, everywhere evenly echinulate-granulate.

Singapore, U. S. Expl. Exped., No. 2038, Yale Mus.

Probably this species has been included under *A. secale* by several writers. Indeed, it is quite probable that Studer himself so included it, for he refers to specimens of the latter from Singapore, but he did not describe them. It does not appear to agree with *A. secale* (Brook), *non* Stud., which has more appressed corallites, but it may be that it varies in this respect.

In general appearance this has some resemblance to *A. calamaria* (Br.), but the primary branches of the latter do not coalesce into a basal disk, at least in the type, and its branchlets are more obtuse, shorter and thicker, and the corallites do not agree very closely.

Acropora fraterna Ver., sp. nov.

PLATE XXXVI. FIGURE 18. PLATE XXXVI B. FIGURE 9

One of the specimens in the Yale Museum labelled as *M. paxilligera* by Dana, differs specifically from another type-specimen, which agrees well with his description and figure.

This coral forms a large, flat-topped, turbinate clump, covered above with stout, conoidal, subacute branches ; below, it arises from a stout, compact pedicel, 6 to 7 inches (150 to 175^{mm}) in diameter, rapidly widening upward. It is formed by large, obliquely ascending, primary branches, which are almost completely coalesced into a thick mass, with only a few submarginal openings, and covered beneath with numerous, rather large (1.10 to 1.30^{mm}), stellate, immersed calicles, but without any projecting branchlets nor prominent corallites.

The upper marginal branches are stout, very obliquely divergent, and digitate, more or less coalesced proximally. The upright branches of the central portions are not crowded, elongate-conical, 35 to 50^{mm} long, 15 to 25^{mm} in diameter at base, regularly tapered, subacute.

The axial corallites are rather large, mostly 3 to 3.5^{mm} in diameter; 1 to 2^{mm} exsert, with moderately thick, very porous walls, strongly costulated externally ; septa usually 12, narrow.

The radial corallites are very unequal ; the larger distal ones are $2–3^{mm}$ exsert, about $1.5–2^{mm}$ in diameter, tubular, scarcely compressed, obliquely truncated or labellate, with a dimidiate lower lip, which is not thickened nor incurved, or but slightly so ; inner lip usually pretty well developed, free, but thin, often entirely adnate ; outer walls strongly costulate, with rows of large pores between the costulæ. Septa usually 12, the six primaries rather narrow ; the others almost rudimentary.

Between the larger radial corallites there are many crowded smaller ones, 0.5 to 1.25^{mm} in diameter, short-tubular, rather exsert, with thin, costulate walls, and an open terminal aperture, which may be more or less oblique. The larger corallites stand out rather

prominently and are sometimes squarrose, but in other cases form an angle of about 68°–75°. The cœnenchyma is loosely porous, or reticulate-porous. Immersed calicles become numerous on and between the bases of the branches.

Tahiti, U. S. Expl Expd. No. 2032.

The *A. gemmifera* (Br.) grows in much the same form as this species, so far as the upper side is concerned, but it does not seem to form a solid basal disk, and its short, conical, lateral branchlets do not occur in this species. The corallites are quite different in form.

Acropora Wardii Ver, sp nov

PLATE XXXVI FIGURE 13 PLATE XXXVI B FIGURE 4 PLATE XXXVI F FIGURE 4

Coral a flat-topped, corymbose clump, arising from a large, thick, short base, 150 to 250^{mm} broad. The larger specimens are 18 to 20 inches across (450 to 500^{mm}), and 100 to 125^{mm} high. The lower side of the disk is composed of firmly coalesced, nearly horizontal, primary branches, united into a large, thick, continuous plate, except near the margin, where it becomes lobate; most of the under side is covered with epitheca, to within 50 to 70^{mm} of the margin, where the cœnenchyma is at first compact, nearly even, and finely granulated, but nearer to the margin it bears slightly elevated corallites, becoming more prominent close to the margin.

The upper surface is evenly and rather closely covered with short, stout, often crowded and subangular, bluntly tapered, upright branches, the submarginal ones becoming oblique, and those at the edge short, nearly horizontal, often coalesced. The central ones are mostly 35 to 40^{mm} high, and 15 to 20^{mm} thick at base; they are mostly separated by intervals of 6 to 10^{mm}. The cœnenchyma between their bases is covered with immersed calicles.

The axial corallites are of moderate size, often not much larger than the radial ones, diameter 2.5 to 3^{mm}, 0.5 to 1^{mm} exsert, with a porous thickened wall, strongly costulate externally; calicle small, about 0.75^{mm}, with 12 narrow septa.

Radial corallites short, mostly 1.5 to 2^{mm}, numerous, much crowded, with a dimidiate or auricular lower lip, which is only a little thickened and is strongly costulate externally, with small pores between the costulæ. The larger distal corallites are about 1.5 to 1.7^{mm} thick, often short, dimidiate-tubular, scarcely, if at all, compressed, with the upper side cut away obliquely, so that the

aperture is wide-open, and looks upward and outward, and is visible in a side view. The inner lip is often free for a short distance, but usually wholly adnate. Lower down the corallites rapidly become shorter and the lower lip becomes a thin crescent-shaped margin, and at the base many calicles are wholly immersed.

The septa are all narrow, except the directives; the six secondaries are often present, but very narrow; in other cases abortive. Cœnenchyma openly reticulate-porous.

East Indies or Polynesia? (coll. H. A. Ward), Yale Museum, No. 6151. Also in Field Columbian Museum.

In form of coral and mode of growth, this species resembles *A. Guppyi* (Brook), as figured by Brook, but the latter has stouter branches with much larger axial corallites, and the walls of the latter are not costulate.

It has some resemblance to *A. conigera* (D), but the branches are larger and more obtuse; the calicles are shorter, more crowded, and less labrate; the walls are more regularly costulate and fenestrate; and the cœnenchyma is finer and not so rough.

Several specimens were in the Ward collection several years ago (Nos. 6118, 6120, 6151), from which the above description was made. That collection was afterwards sold to the Field Columbian Museum. A few fragments of No 6151 are in the Museum of Yale University.

Acropora polymorpha (Brook) Ver.

Madrepora polymorpha Brook, Ann. and Mag. Nat. Hist, viii, p 466, 1891. Catal. Mad. Brit. Mus., p. 169, 1893.

Madrepora abrotanoides Dana, Zooph, p. 477, pl xli, fig. 1, 1846 (*non* Lam.)

Several branches from specimens labeled as *M. abrotanoides* by Dana are in the Yale Mus. (No. 4202). A careful study of these shows that they belong to two distinct species.

That which is most fully represented is the species figured by Dana. One of our specimens appears to be the figured branch. It agrees with Brooks' description of his *M. polymorpha*.

It has unequal, compressed-nariform, thick-walled, prominent, divergent radial corallites, with the small, elliptical, stellate calicles looking obliquely upward; outer lip thick, rounded, and prominent; inner lip usually free for some distance. External surface of wall is densely and finely echinulo-granulate, not costulate.

Between the larger corallites are many small tubular or verruciform corallites with a small terminal or subterminal calicle. The cœnenchyma is compact and finely granulated.

Acropora neglecta Ver., sp nov

PLATE XXXVI. FIGURE 21. PLATE XXXVI E FIGURE 7.
PLATE XXXVI F. FIGURE 5

The other species, mixed with the last, which I have been unable to identify, is represented only by a single terminal branch, 13^{mm} in diameter, with a few short, divaricate branchlets, three arising at one point in one case. It was evidently arborescently branched.

Axial corallites about 2.5^{mm} in diameter, and 3^{mm} exsert, with strongly costulate wall, and 12 very distinct subequal septa, the directives wider.

Radial corallites are tapered, tubular, or conoidal, ascending, not compressed, obliquely truncate, with the round stellate calicle looking upward and somewhat outward ; outer lip a little prominent, not much thickened, narrowed, and incurved; inner lip thin, usually free for a short distance, but often entirely adnate. Outer wall strongly costulate, with the costulæ rather coarsely echinulate, and with small pores in rows between the costulæ.

Septa 12, unequal, but all narrow, the directives a little wider. There are but few small calicles between the larger, and none immersed.

The larger corallites are openly arranged, much fewer than in *polymorpha*, and very different in the conoidal form and strongly costulate exterior. The cœnenchyma is irregularly and strongly pitted and roughly echinulate, in series. This is a true *Eumadrepora* (Brook).

Probably this specimen was from Singapore, or that region. U. S. Expl. Exped., 1846. No. 6126, Yale Mus.

Acropora pumila Ver

Madrepora pumila Verrill, Comm. Essex Inst., v, p. 23, 1866. Brook, p. 166.

PLATE XXXVI FIGURE 5 PLATE XXXVI A. FIGURE 5
PLATE XXXVI D. FIGURE 9

In addition to the original description, which is pretty complete, the following points are noted. The calicles, both axial and radial, are unusually small, mostly not over 0.5^{mm}, and some on the lower branchlets are immersed and still smaller, but the immersed calicles are scattered and inconspicuous. On the lower branchlets the axial corallites are often so thickened that the calicle becomes very small, or almost obsolete. Some of the calicles, both radial and axial, have 12 septa ; the primaries are all rather narrow and subequal ; the secondaries very narrow.

Many of the lateral corallites are verruciform or low conoidal, with a wide thick base.

The cœnenchyma and walls are nearly uniformly covered with close, rough, not very minute granules.

Bonin Islands, U. S. North Pacific Expl. Exp. Yale Mus., No. 1687.

Acropora striata Ver.

Madrepora striata Ver., Comm Essex Inst., v, p. 24, 1866 Brook, p 178.

PLATE XXXVI FIGURES 4, 4*a* PLATE XXXVI A. FIGURES 4, 4*a*
PLATE XXXVI F. FIGURE 7.

This species is notable on account of the large size of the calicles and the thin, flaring lips of the tubular corallites, which have regularly costulate, thin walls.

The axial and gemmiferous radial corallites are either exsert-tubular or somewhat trumpet-shaped, many being distinctly widened distally and 2–2.5^{mm} in diameter, with the wide, round calicle about 1.5^{mm}; they are often 4–5^{mm} long, with thin, flaring, porous edges.

The normal radial corallites are mostly openly tubular, about 3^{mm} long, with the summit obliquely truncated and the inner lip nearly or quite adnate, but not at all appressed nor compressed. The outer lip is thin, but firm, usually somewhat excurved, so that the calicle is widely open (1.5^{mm}) and looks outward and upward. The corallites mostly stand out pretty strongly, at angles of 50° to 70°.

The septa are unusually well developed in the radial corallites; the six primaries nearly or quite meet in the center, rather deep down in the calicles; the directives generally unite: the secondaries are narrow, but usually distinct.

The cœnenchyma is firm, somewhat translucent, but with the surface irregularly pitted and sharply echinulo-granulate.

It is a handsome, shrubby or arborescently branched species, not very closely allied to any other that I have seen, except *A. tubigera*, with which it has several points in common

Ousima, U. S. N. Pacific Expl. Exped. Yale Mus., No. 1688.

Acropora urceolifera Ver., sp. nov.

Madrepora corymbosa Dana, Zoöph., p. 456, 1846 (*non* Lam.).

PLATE XXXVI D. FIGURE 8. PLATE XXXVI E. FIGURE 6
PLATE XXXVI F. FIGURE 18.

It is remarkable that no recent writer seems to have had in hand the species described by Dana as *corymbosa*. A part of the original type is in the Yale Mus., No. 4187, labelled in Dana's handwriting.

It agrees well with his description. I have never met with any other example of the same species. It is easily recognizable on account of its peculiar, more or less urceolate radial corallites, which have thin walls, often constricted below the aperture.

It is very unlike the type of *corymbosa* described by Brook, which is nearly allied to *A. spicifera*, *A. cytherea*, and *A. surculosa*. Dana states that this species is cæspitose, but our fragment is insufficient to determine the form of growth. It is a single nearly straight branch, 50^{mm} long and 10 in diameter, with four divergent branchlets arising from one side, as if it were a proliferous submarginal branch from the upper side of a corymbose or cæspitose clump. The branches are tapered, obtuse.

Axial corallites are rather large and prominent, 3.5^{mm} in diameter and $2–3^{mm}$ exsert, with thick, porous, closely echinulate walls and funnel-shaped calicles, about 1.5^{mm} in diameter.

Radial corallites are thin-walled, and unequal in size and form. The larger ones are rather large and prominent, 3^{mm} long and 2–2.5 in diameter, standing mostly at angles of 45° to 60°, and sometimes in vertical rows. They are tubular, mostly somewhat swollen in the middle and rather suddenly narrowed or constricted just below the orifice, so as to give them an urceolate form; but many are scarcely, if at all, swollen, and have the outer lip incurved, and often slightly beaked, or with the edge lacerate.

The aperture is round, oblique, and looks upward and inward. The corallites are not at all appressed, and the inner lip is usually free for some distance. The walls are thin, but firm, not costulate, but thickly covered with rather strong, sharp, rough spinules, sometimes arranged in costal rows.

Between the larger corallites are many that are small, short-tubular, or verruciform, with the calicle terminal and the lips lacerate.

Septa distinct, but all narrow; the secondaries often rudimentary or abortive.

The cœnenchyma is firm, irregularly pitted, thickly covered with sharp spinules.

Precise locality unknown, E. Indies or Indian Ocean (Dana).

This species differs from all others known to me in the swollen and urceolate form of the radial corallites, with their spinulose walls. *A. neglecta* Ver. approaches it, in this respect, more nearly than any other species.

Acropora armata Ver.

Madrepora armata Brook, op cit., Ann. and Mag. N. Hist., x, p. 452, 1892. Catal. Mad., p. 100, pl. x, figs. A, B, 1893 (?=*A. turbinata* Ver.).

Mr. Brook considered the coral figured by Dana as variety of his *spicifera* (p. 443, pl. 31, figs. 6–6*c*, pl. 33, figs. 4–4*b*) identical with his *armata*.

This does not seem to be the case.

The type of Dana's variety is in the Museum of Yale Univ, No. 2007. It differs in the details of the corallites and cœnenchyma, though it grows in similar form. It also resembles *A. turbinata* in its mode of growth, but it has much smaller calicles than the latter, the walls and cœnenchyma are much less porous, and the outer lip is narrower and more ascending.

A. turbinata agrees, therefore, very closely with *A. armata* and is probably identical with it, for the latter has the same spreading radial corallites and very porous and fragile lower lip as *turbinata*. But Dana's variety has an ascending or almost appressed outer lip, which is compact and strong, though thin, and the corallites and calicles are decidedly smaller. I propose to call the latter *A. cytherella*.

Acropora cytherella Ver, sp. nov.

Madrepora spicifera (var.) Dana, Zoöph., p. 443, pl. xxxi, figs. 6–6*c*, pl. xxxiii, figs. 4–4*b*.

PLATE XXXVI. FIGURE 7. PLATE XXXVI A. FIGURE 7.
PLATE XXXVI F. FIGURE 1.

The coral is vase-shape or salver form, from a stout pedicel, and the under surface of the coalesced branches is covered with divergent calicles and dwarfed branchlets in the type, as figured by Dana.

The branches of the upper side are slender and very proliferous distally, mostly 25 to 35^{mm} long. The axial corallites are about 2^{mm} in diameter and 2–3^{mm} exsert, cylindrical, with firm, finely and regularly costulate walls.

Radial corallites dimidiate-tubular, elongate, 2–3^{mm}, strongly ascending, not truly appressed; outer lip long, thin, but not fragile, half-round, with the aperture very oblique; inner lip thin, often free to some extent, but mostly adnate; wall finely and regularly costulate with a few very small pores in the grooves. Cœnenchyma irregularly and roughly pitted, and spinulose, rather firm.

Calicles small, 0.5 to 0.8^{mm}. Septa distinct, but narrow, in the axial corallites, usually 6, sometimes 12; all nearly abortive in the radial calicles.

Fiji Is., U. S. Expl. Exped., No. 2007.

This is not identical with *A. armata*, as supposed by Brook. See remarks under the latter, above.

It is closely allied to *A. surculosa* and *A. cytherea*, but has much smaller corallites and calicles than either of those species, and differs in other ways.

In the very numerous, small and slender upright branchlets this species resembles *A. arcuata* (Br.), to which it appears to be nearly allied.

Acropora symmetrica (Brook) Ver.

Madrepora symmetrica Brook, p. 94, pl. xv, 1893.
?=*Madrepora corymbosa* (*pars*, Lam.). Restricted by Brook, p. 97
?=*Madrepora surculosa* Dana, var , p 445.

PLATE XXXVI FIGURE 8. PLATE XXXVI A. FIGURE 8.

A large specimen from Zanzibar, in the Yale Mus., seems to agree closely with Brook's type, as described and figured, but is rather more proliferous beneath and has somewhat longer upright superior branchlets.

Our specimen is a broad, flat-topped corymbose coral, with a stout pedicel, nearer to one side. It measures about 16x18 inches, or 400x450^{mm}, across the top.

The free part of the disk, beneath, on the widest side, is 12 inches, or 300^{mm}. Diameter of pedicel, 3.5 inches, or 88^{mm}. The disk is composed of intricately coalesced branches, with numerous rounded openings, 12–30^{mm} or more in diameter. The under side is covered with an abundance of short, irregular branchlets, more or less appressed toward the margins, giving it a rough appearance. They spread nearly at right angles on and near the pedicel, and are covered like the cœnenchyma with large immersed calicles and others that are short and appressed.

The upper side is thickly covered with rather slender, acute, furcate and proliferous branches, upright in the middle and curved outward and upward toward the margins, so as to rise to about one general level. Many of them are 70 to 80^{mm} long, with the branchlets mostly 25 to 50^{mm} long, and mostly about 6 to 8^{mm} in diameter, but often with shorter distal ones, 5–10^{mm} long. They are mostly separated by spaces of 10 to 20^{mm} at tips.

The axial corallites are slender, about 1.3 to 1.5^{mm} in diameter, and 1 to 3^{mm} exsert. They have a rather thin but firm, costulate wall; septa usually only six, and all narrow.

The normal distal radial corallites are ascending and loosely imbricated distally, round, dimidiate-tubular, with an elongated, straight, slightly incurved, or a little flaring, hollow lower lip, which is sometimes very slightly thickened ; its edge is obtuse and denticulate ; wall strongly costulate with rows of pores in the grooves ; inner lip thin, mostly adnate.

The calicles are rather large, about 1^{mm} in diameter, round or nearly so, and look upward and slightly outward.

Lower down, the lower lip rapidly becomes shorter and mostly disappears on the bases of the branchlets and on the larger branches, where open immersed calicles are numerous and conspicuous ; they are usually at least 1^{mm} in diameter.

Septa in all the radial calicles are nearly all abortive or rudimentary ; often two very narrow directives are alone present ; in other cases 4 or more additional rudimentary ones can be seen with a lens, especially in the immersed calicles.

Cœnenchyma is roughly and irregularly reticulately pitted and vermiculate, and with rough echinulations in series.

Zanzibar. No. 79. Exchange, from Peabody Inst., Salem. Branches of other specimens, with longer branchlets, from Mozambique, are in the collection.

Although this specimen appears to be identical with *A. symmetrica*, I have described it pretty fully, to show its probable identity with *A. surculosa* Dana

I have compared it directly with Dana's original types of the latter in the Yale Museum, and can find no tangible differences between it and No. 4178, from Tahiti, and others, in the details of the corallites. The walls, lips, calicles, and septa are identical, except that the calicles of the Tahiti specimen may be in part a trifle smaller, and the branchlets that I have at hand are also a little smaller, but they do not differ so much as do those from contiguous parts of our specimen.

The somewhat greater length of the upright branches of the upper side and the abundance of imperfect proliferous branchlets on the lower side, are the only noticeable differences.

These are both very variable characters in corymbose corals of this group. Therefore I believe that the two forms should be united.

The above description may be considered as essentially a description of *A. surculosa*, as to the details of the corallites, calicles, and cœnenchyma.

It is certain that several of the forms admitted as "species" by Brook in this group are very closely related, and perhaps are mere local or growth-varieties of one species. The *A. corymbosa* (Lam.) as restricted and described by Brook, from the type, with its several varieties, belongs to this series, and bears the earliest name.

It seems to me probable that a careful study of a good series of specimens would compel us to unite *A. surculosa*, *A. turbinata*, *A. armata*, and *A. symmetrica* as varieties of *A. corymbosa*. It may also become necessary to unite with these *A. cytherea* and *A. cytherella*, as somewhat more marked varieties.

All these forms are essentially alike in form and mode of growth; in the structure of the corallites; and especially in the rudimentary condition of the septa. All have an abundance of rather large, open, immersed calicles on the larger branches.

Brook puts all these forms in section C of his subgenus *Polystachys*, but he puts *surculosa* in subsection *c*, and the rest in subsection *a*. I can see no grounds whatever for this distinction; moreover these forms do not, as a rule, conform with the characters given by him for his section C.

Some of the forms referred to *corymbosa* by Klunzinger (as his fig. 1, pl. iv, and fig. 2, pl. 1) seem to me very different from the *corymbosa* of Brook (after Lam.), although admitted by Brook, without question, in his synonymy.

As photographed by Klz., the radial corallites are speading and have a decidedly thickened outer lip, while Brook states the outer lip is "half-tubular or labellate" and "very fragile." Moreover the Red Sea form is represented as having much larger and stouter branches than the type.

This stout-branched Red Sea form, with thickened walls and stout lip to the corallites, seems to me a distinct species. I have examined several specimens of this sort, from the Red Sea, but have not seen a good series.

For the same reason, I have not thought it desirable, at this time, to formally unite all the forms, mentioned above, as varieties under *A. corymbosa*, for of some of them I have seen only single examples. Far better series are doubtless to be seen in the British Museum and probably, also, in the large collections of South Pacific corals recently added to the Mus. Comp. Zoölogy by Mr. A. Agassiz, but which I have not yet seen.

The *M. corymbosa* of Dana is a very different species. See *A. urceolifera*, p. 251.

Acropora millepora (Ehr.), and var. **squamosa** (Brook).

Madrepora millepora Brook, op. cit., p. 116, 1893. Dana, Zooph., p. 446, pl xxxiii, fig. 2, 1846.

Madrepora squamosa Brook, Ann. and Mag. N. H., x, p. 463, 1892; op. cit., p. 120, pl. xx, fig. B.

Brook has redescribed the type of Ehrenberg. He considered it distinct from the *M. millepora* of Dana, and described, as a new species (*A. squamosa*), the form that he identified with Dana's. To me, the differences mentioned seem trivial and not of specific value.

In either case, Dana apparently had both forms in view when he described his *M. millepora*. Portions of the types of his species of that name are in the Yale Museum, and also a good series of specimens of this species received from Singapore (coll. Capt. W. H. A. Putnam).

Several of the latter agree with the *A. squamosa* (Brook), but I cannot distinguish them as more than a slightly marked variety of *A. millepora*.

I think it probable, also, that *A. subulata* is only a longer-branched variety of *A. convexa*.

Acropora nasuta (Dana) Ver.

Madrepora nasuta Dana, Zooph., p. 453, pl. xxxiv, fig. 3, 1846.

Madrepora nasuta and var. *crassilabia* Brook, op. cit., pp. 73, 74, 1893.

One of Dana's types is in the Museum of Yale University (No. 2026, and 4187, branches), as well as other similar specimens from different sources. It is the form described as var. *crassilabia* by Brook.

This type forms a rounded, convex, thick clump of divergent branches and branchlets, which show no tendency to coalesce or form a basal disk. The marginal branches are divergent, stout, and shorter than the others. In these respects it agrees with Dana's figure, but not with the larger specimen that he described.

The radial corallites are prominent, compressed, and truly nariform, as well described by Dana. The lower lip is elongated, narrowed, incurved, and decidedly thickened, as in the type of *crassilabia*. The edge of the lip is usually lacerate and rough. The walls are finely echino-costulate. The calicles are elliptical, with 12 septa, more conspicuous in the immersed calicles of the bases of the branches. Tahiti (Dana).

Acropora cucullata Ver., sp. nov.

PLATE XXXVI D. FIGURES 8, 8*a*. PLATE XXXVI E. FIGURE 1.

The coral forms a broad, flat-topped, corymbose clump, covered with rather long, moderately stout, upright, dichotomous, and more or less proliferous branches, those toward the margin arching outward at the base; on the under side usually with numerous divergent, abortive branchlets.

The upright branches are mostly 8 to 10^{mm} in diameter, and 35 to 50^{mm} or more long, round, or subangular when crowded, little tapered to near the ends, which are rapidly narrowed and a little obtuse.

Axial corallites moderately thick, about 2.5^{mm}, scarcely exsert; wall thick, porous, rounded, costulate, with many pores between the costulæ.

Radial corallites unequal; the larger normal ones are large, prominent, about 2.5–3^{mm} long, 2–2.5^{mm} broad, divergent at angles of 45°–70°, a little compressed, arched-nariform or cucullate, with the wall thickened and convex on the middle of the outer side, and the thick, obtuse outer lip arched and incurved, so as to produce a hooded form on many of the larger corallites. The edge of the lip is thin and lacerate. Between these are many smaller, short, open tubular or subnariform corallites, with thin lacerate lips, and also many that are immersed, with wide, deep calicles, 1–1.10^{mm} in diameter.

The septa are all narrow, and part of them are often rudimentary. In the larger radial corallites the directives are more distinct, but ten other subequal narrow septa are usually visible. In the immersed calicles they are mostly obsolete, or nearly so, except the directives, which may meet in the middle, in some cases. But many calicles occur in which all six primary septa are well developed, deep down in the calicle; others occur with 12 distinct, equal septa, at the edge.

Many of the upright branches also bear more or less numerous gemmiferous corallites, rather longer and larger than the normal radial ones, about 4^{mm} long and 2.5^{mm} broad. These are also at first cucullate with a thick, arched outer lip, and bear 1–4 small, arched corallites; some may later become more evenly tubular, like the axial corallites. All the corallites have finely costulate walls.

Immersed corallites are abundant on the primary branches; less numerous beneath. The cœnenchyma is porous, with numerous, elongated pits, and roughly echinulate.

Indo-Pacific (coll. Ward), No. 6130, Yale Museum. Also Field Columbian Museum. This species is somewhat allied to *A. nasuta*, but is different, not only in growth, but the corallites are more arched and incurved; the walls are more finely costulate and not so rough; the septa are less developed; and the texture more porous.

In mode of growth and form of branches it resembles *A. Kentii* (Br.) and *A. obscura* (Br.), but neither of those species have the peculiar form and structure of radial corallites seen in this.

Acropora paniculata Ver, sp nov

PLATE XXXVI D FIGURES 7, 10, 10*a*. PLATE XXXVI E. FIGURE 5.

Coral much branched, forming small dense clumps, 150 to 200^{mm} high and broad, in which the principal branches, which are 12 to 15^{mm} in diameter at base, are repeatedly forked; branches proliferous on all sides, with slender ascending or somewhat excurved branchlets of different lengths, thus producing panicle-like groups of branchlets. The terminal branchlets may be 20 to 40^{mm} long, and 3 to 5^{mm} in diameter, tapered, acute, often bearing 1–3 long, exsert, tubular corallites, besides the axial one.

The axial corallite is slender and exsert, about 1.5^{mm} wide and 3 to 5^{mm} long, with a thin strongly costulate wall and a regular 12-rayed calicle.

The exsert, tubular, lateral gemmiferous calicles may be 6 to 8^{mm} long and 1.5^{mm} in diameter, with 1–3 small basal buds, and costulate wall; the calicle is round and terminal, as in the axial one, with 12 distinct septa; some of them are slightly larger or clavate distally.

The normal radial corallites are prominent, ascending, elongate-tubular, obliquely truncate, nearly as large as the axial ones, with round calicles; the more distal ones usually have the inner lip free for some distance and the end only slightly obliquely truncated, with thin, porous, but firm, costulate walls; those lower down have the inner lip adnate, or nearly so, and the aperture more oblique, with the lower lip a little prolonged, and sometimes a little thickened; some of them are slightly wider distally; all are strongly costulate.

On the bases of the branches they become short-tubular, or verruciform, and many are entirely immersed; these have calicles about 1^{mm} in diameter, with 12 narrow septa.

The cœnenchyma is firm, sparingly porous, irregularly pitted, sparsely covered with minute, sharp granules.

Fiji Islands (?) or Tahiti, Yale Museum (coll. Mrs. Mills), No. 3810.

This species has some resemblance to *A. tubigera*, but the form of the radial corallites is different and it lacks the numerous long, tubular, clustered, exsert corallites of the outer branches. The texture of the cœnenchyma is also different and less compact. The mode of branching is similar, and both have similar costulate walls and stellate calicles.

It also has some resemblance to *A. delicatula* (Br., pl. xxviii), but the latter is more suffruticose, with more profuse and more slender branchlets. The tubular corallites are longer and more numerous.

Acropora acuminata Ver.

Madrepora acuminata Ver., Bull. Mus Comp. Zoöl, i, p 40, 1864. Brook, op cit, p 38, 1893

PLATE XXXVI D. FIGURE 5. PLATE XXXVI E FIGURE 2. PLATE XXXVI F. FIGURE 11.

This arborescent species branches much like some specimens of *A. muricata*, var. *cervicornis*. The long branches are apt to arise several near together and diverge widely, tapering very gradually. The larger branches are about 20 to 30^{mm} in diameter and 150 to 250^{mm} long.

The axial corallites are of moderate size, not swollen. The normal radial corallites are mostly of one form but unequal in size, widely divergent, mostly standing at angles of 60° to 80°, sometimes 90°. They are mostly rather large, 2 to 2.2^{mm} in diameter, and about the same in length, or 2 to 2.75^{mm}, with rather open, nearly round calicles, 1 to 1.2^{mm} in diameter, looking outward and upward.

The corallites are regularly short tubular, with the end very obliquely truncated or dimidiate and often slightly enlarged, rarely a little compressed. Outer lip a little thickened, often slightly incurved, obtusely rounded; inner lip thin, the free part not half as long as the outer lip. Wall firm, strongly costulate, with small pores in the grooves. Between the large corallites there are many small ones of similar form, but with the calicle less oblique and lips thinner.

On the large branches there are also, in some cases, many longer, spreading, gemmiferous, tubular corallites, with the calicle more nearly or quite terminal. The larger of these are nearly like the true axial corallites in form, about 3–4^{mm} long, and 2.25–2.75^{mm} in diameter; they mostly bear only 1–4 very small basal calicles. The walls are roughly and strongly costulate.

Septa very narrow in all the calicles: usually there are six narrow primaries, the directives a trifle wider; sometimes a few rudimentary secondaries are also present.

Cœnenchyma irregularly and roughly pitted, or vermiculate and echinulate.

Kingsmills Islands (coll. A. Garrett). Received from the Mus. Comp. Zoöl. No. 1007.

The above description is from one of the original types. In general appearance and mode of growth it considerably resembles *A. grandis* (Brook) and *A. intermedia* (Brook), as figured by Brook (op. cit., pl. i), but the corallites of both these are quite different, being small and with a more nearly terminal aperture than in our species.

Acropora Ehrenbergii (E. and Haime) var. **scandens**?

?*Madrepora Ehrenbergii* Edw. and Haime, Hist Corall., iii, p. 143

?*Madrepora scandens* Klunz., Corall Rothen Meeres, ii, p. 26, pl. ii, fig. 6, pl. iv, fig. 3, pl. ix, fig. 21. Brook, p. 48

PLATE XXXVI D. FIGURE 6 PLATE XXXVI E. FIGURE 3

A large and fine specimen, apparently of this species, but not agreeing very closely with the descriptions, was studied by me. It was formerly in the Ward collection.

It consists of a very large, one-sided, irregularly reticulated corallum, about three feet (900^{mm}) broad and two feet (600^{mm}) high. It arises obliquely from a stout pedicel. The main branches, which are $25–62^{mm}$ in diameter, diverge and rapidly subdivide into smaller branches, which are very proliferous, the branches being arranged somewhat in one plane. The distal small branches rise up very obliquely and have tapering tips; many small, short, proliferous branches, with similar tips are scattered over the upper side of the frond. On the under side the branches coalesce into an open reticulum, with large, unequal and very irregular meshes, 75 to 100^{mm} long and 25 to 38^{mm} wide.

The larger basal branches bear divaricate, conical branchlets, 10 to 20^{mm} long, 5 to 10^{mm} thick, and others 50^{mm} or more long, and 12 to 15^{mm} thick, which are proliferous and bear smaller divaricate, conical branchlets, 5 to 12^{mm} long. These small, conical branchlets have a large, conical axial corallite, often 5 to 12^{mm} long and 3 to 5^{mm} in diameter at base. They are covered with round, short-tubular, obliquely truncate corallites standing at about 45°, with a round, open calicle; outer lip thickened, obtuse.

Septa 12, all narrow, the directives a little wider. On the larger branches are scattered rather large, open calicles, about 1^{mm} in diameter. Some of the calicles have a long acuminate outer lip

Cœnenchyma firm, rough, irregularly and roughly pitted, and rudely echinulate.

On the upper branches the larger radial corallites are divaricate, tubular, obliquely truncate, with the calicles opening outward, and with a short, thick, rounded outer lip.

Red Sea ? (coll. Ward), probably now in the Field Columbian Museum. Fragments are in the Yale Museum No. 0139.

EXPLANATION OF PLATES XXXVI–XXXVI F

Plate XXXVI.

[All the figures on this plate are natural size.]

Figure 1.—*Acropora tubigera* Horn. Branchlet from the original type. P 289 No. 1483.

Figure 2.—The same Upright branch from a Singapore specimen. No 1870

Figures 2*a*, 2*b*.—The same specimen. Proliferous tubular corallites and branchlets from the outer and lower sides.

Figures 3, 3*a*.—*Acropora prolixa* Ver. Branchlets from the type. No. 1686. P. 287.

Figures 4, 4*a*.—*Acropora striata* Ver. Branchlets from the type No. 1688 P. 251

Figure 5.—*Acropora pumila* Ver. Branchlet from the type. No 1687. P. 250.

Figure 6.—*Acropora turbinata* (Dana). Proliferous upright branch from the type. No. 2017 P. 242.

Figure 7.—*Acropora cytherella* Ver., sp. nov. An upright branchlet from the type. No. 2007. P. 253.

Figure 8.—*Acropora symmetrica* (Br.). An upright branchlet from a Zanzibar specimen. No. 79. P. 254.

Figure 9.—*Acropora dissimilis* Ver., sp. nov. A terminal branchlet from the type. No. 4841. P. 236.

Figure 10.—*Acropora austera* (Dana) A terminal branchlet from the type. No. 4190. P. 226.

Figures 11, 11*a*, 11*b*.—*Acropora tumida* Ver. Branchlets from the type. No. 886. P. 241.

Figure 12.—*Acropora digitifera* (Dana). A terminal branch from the type. No. 480. P. 228

Figure 13.—*Acropora Wardii* Ver., sp. nov. An upright branchlet from the type. No. 6151. P. 248.

Figure 14.—*Acropora secale* (Stud.). Distal part of an upright branchlet of the type. Ceylon. No. 3068. P. 244.

Figures 15, 15*a*.—*Acropora secaloides* Ver., sp. nov. Distal and middle portions of two upright branchlets of the type. No. 2083. P. 245.

Figures 16, 16*a*.—*Acropora effusa* (Dana). Two upright branchlets from the type. No. 3063. P. 229.

Figure 17.—*Acropora acervata* (Dana). An upright branchlet from the type. No. 4185. P. 220.

Figure 18.—*Acropora fraterna* Ver., sp. nov. Distal part of an upright branchlet from the type. No. 2082. P. 247.

Figure 19.—*Acropora indurata* Ver., sp. nov. Branch from the type. No. 6155. P. 230.

Figure 20.—*Acropora pachycyathus* Ver., sp. nov. Branches from the type. No. 6141. P. 236.

Figure 21.—*Acropora neglecta* Ver., sp. nov. A terminal branch of the type. No. 6126. P. 250.

Figure 22.—*Acropora appressa* (Ehr., Dana). Branchlet. ½. P. 222.

Plate XXXVI A.

[All the figures on this plate are enlarged about two diameters.]

Figure 1.—*Acropora tubigera* (Horn). A branchlet from an outer upright branch of the type. No. 1483. P. 239.

Figure 2.—The same. Distal part of an upright branch from a Singapore specimen. No. 1370. ×2.

Figures 2*a*, 2*b*.—The same specimen. Proliferous branchlets from the lower side of a lateral branch. ×2.

Figures 3, 3*a*.—*Acropora prolixa* Ver. Branches from the type. No. 1686. ×2. P. 237.

Figures 4, 4*a*.—*Acropora striata* Ver. Branches from the type. No. 1688. ×2. P. 251.

Figure 5.—*Acropora pumila* Ver. A branchlet from the type. No. 1687. ×2. P. 250.

Figure 6.—*Acropora turbinata* (Dana). A proliferous upright branch from the type. No. 2017. ×2. P. 242.

Figure 7.—*Acropora cytherella* Ver. A proliferous upright branch from the type. No. 2007. ×2. P. 253.

Figure 8.—*Acropora symmetrica* (Brook). An upright branch from No. 79. ×2. P. 254.

Figure 9.—*Acropora dissimilis* Ver. (=*M. echidnæa* D.) A terminal branch of the type. No. 4341. ×2. P. 296.

Plate XXXVI B.

[All the figures on this plate are enlarged about two diameters.]

Figure 1.—*Acropora austera* (Dana). A terminal branchlet from the type. No. 4190. P. 226.

Figures 2, 2*a*, 2*b*.—*Acropora tumida* Ver. Portions of the type. No. 886. ×2. P. 241.

Figure 3.—*Acropora digitifera* (Dana). A branch from the type. No. 430. ×2. P. 228.

Figure 4.—*Acropora Wardii* Ver. An upright branchlet from the type. No. 6151. ×2. P. 248.

Figure 5.—*Acropora secale* Stud. The distal part of upright branches from the type of Dana. No. 3063. ×2. P. 244.

Figures 6, 6*a*.—*Acropora secaloides* Ver. Distal and middle portions of two upright branches of the type. No. 2088. ×2. P. 245

Figures 7, 7*a*.—*Acropora effusa* (Dana). Two upright branches of the type. No. 3063. ×2. P. 229.

Figure 8.—*Acropora acerrata* Dana. An upright branch of the type. No. 4185. ×2. P. 220

Figure 9.—*Acropora fraterna* Ver. Distal part of an upright branch of the type. No. 2032. ×2. P. 247.

Figure 10.—*Acropora appressa* (Dana). Branchlet. ×2. P. 222.

PLATE XXXVI C.

[All figures on this plate are enlarged about two diameters.]

Figure 1—*Acropora microphthalma* Ver. A small branch from the type No. 774. ×2. P. 282.

Figure 2.—*Acropora diffusa* Ver. Portion of one of the types. No. 1808 ×2. P. 228.

Figure 3.—*Acropora stellulata* Ver., sp. nov. Part of a branch of the type. No. 435. ×2. P. 238.

Figure 4.—*Acropora Luzonica* Ver., sp. nov. Portion of a branch of the type No. 1809 ×1½. P. 281.

Figure 5.—*Acropora pachycyathus* Ver., sp. nov. A branch of the type. No. 6141. ×1⅜. P. 286.

Figure 6.—*Acropora indurata* Ver., sp. nov A branch of the type. No. 6155. ×1⅜. P. 230.

PLATE XXXVI D.

[All the figures on this plate are natural size, except 1*a*, 2*a*, 9, 10, 10*a*, 11.]

Figure 1.—*Millepora nitida* Ver. Part of one of the types. No. 1458. 1/1. P. 197.

Figure 1*a*.—The same specimen. Surface. ×5.

Figure 2.—*Millepora Braziliensis* Ver. Part of a branch of one of the types. No. 1461. 1/1. P. 197.

Figure 2*a*.—The same specimen. Portion of the surface. ×5.

Figure 3.—*Acropora urceolifera* Ver., sp. nov. Branch of the type. No. 4187. 1/1. P. 251.

Figure 4.—*Acropora appressa* Ehr. Branches from Dana's type. No. 2029. 1/1. P. 220.

Figure 5.—*Acropora acuminata* Ver. Part of one of the types. No. 1007. 1/1. P. 260.

Figure 6.—*Acropora Ehrenbergii*, var. *scandens*? Klz. Branch from No. 6189. 1/1. P. 261.

Figure 7.—*Acropora paniculata* Ver., sp. nov. One of the outer branches of the type. No. 3810. 1/1. P. 259.

Figure 8.—*Acropora cucullata* Ver., sp. nov. Two curved upright branches from near the margin of the type, 8*a*. A marginal branch from the under side. No. 6180. [illegible]. P. 258.

Figure 9.—*Acropora pumila* Ver. A branchlet from the type. No. 1687. × 2½. P. 250.

Figures 10, 10*a*.—*Acropora paniculata* Ver., sp. nov. Portions of branchlets from the type. No. 3810. × 2[illegible]. P. 259.

Figure 11.—*Acropora effusa* (Dana). Part of a branchlet of the type. No. 3063. × 2[illegible]. P. 229.

Plate XXXVI E.

Figure 1.—*Acropora cucullata* Ver., sp. nov. Two ascending branchlets of upper side of type. No. 6130. × 2. P. 258.

Figure 2.—*Acropora acuminata* Ver. Part of a branch of type. No. 1007. × 2. P. 260.

Figure 3.—*Acropora Ehrenbergii*, var. *scandens?* (Klz.). Branch of No. 6139. × 1[illegible]. P. 261.

Figure 4.—*Acropora appressa* (Ehr.). Branches of Dana's type. No. 2029. × 1[illegible]. P. 222.

Figure 5.—*Acropora paniculata* Ver., sp. nov. Terminal branchlet of the type. No. 3810. × 1$\frac{2}{10}$. P. 259.

Figure 6.—*Acropora urceolifera* Ver., sp. nov. Branch of the type. No. 4187. × 1[illegible]. P. 251.

Figure 7.—*Acropora neglecta* Ver., sp. nov. Distal part of branch of the type. No. 6126. × 1[illegible]. P. 250.

Plate XXXVI F.

Figure 1.—*Acropora cytherella* Ver., sp. nov. Branchlets of type. No. 2007. × 2[illegible]. P. 258.

Figure 2.—*Acropora turbinata* (Dana). Branchlets of the type. No. 2017. × 2[illegible]. P. 242.

Figure 3.—*Acropora tumida* Ver. Branchlet of type. No. 886. × 2[illegible]. P. 241.

Figure 4.—*Acropora Wardii* Ver., sp. nov. Part of tip of upright superior branchlet of type. No. 6151. × 2[illegible]. P. 248.

Figure 5.—*Acropora neglecta* Ver., sp. nov. Part of branch of type with small lateral branchlet. No. 6126. × 2[illegible]. P. 250.

Figure 6.—*Acropora pachycyathus* Ver., sp. nov. Portion of type. No. 6141. × 2[illegible]. P. 236.

Figure 7.—*Acropora striata* Ver. Part of a branch of the type. No. 1686. × 2[illegible]. P. 251.

Figure 8.—*Acropora tubigera* (Horn). Branchlets of a typical specimen. No. 1370. × 2[illegible]. P. 239.

Figure 9.—*Acropora Luzonica* Ver., sp. nov. Portion of a branch of the type. No. 1809. × 2[illegible]. P. 231.

Figure 10.—*Acropora stellulata* Ver., sp. nov. Portion of a branch of the type. No. 485. × 3. P. 238.

Figure 11.—*Acropora acuminata* Ver. Portion of a branch of a cotype. No. 1007. ×3. P. 260.

Figure 12.—*Acropora indurata* Ver., sp. nov. Small branchlet of the type. No. 6155. ×2⅓. P. 230

Figure 13.—*Acropora urceolifera* Ver., sp. nov. Tip of branch of the type. No. 4187. ×2⅓. P. 251.

Figure 14.—*Acropora prolixa* Ver. Branchlet of the type. No. 1686. ×2⅓. P. 237.

Figure 15.—*Acropora microphthalma* Ver. Branch of the type. No. 774. ×3. P. 232.

Figure 16.—*Acropora diffusa* Ver Portion of a branch of a cotype. No. 1808. ×3. P. 228.

ADDENDA.

Acropora effusa (Dana), see p. 229, and *A. secale* (Stud.), see p. 244.

Under these species I mentioned that they are closely allied, as shown by the types.

A later comparison of the types, with reference to their relationship, shows that, judging from these two specimens, they cannot properly be united, although they agree in mode of growth and some other characters.

The corallites show very evident differences without transitional forms. The axial corallites of *secale* are distinctly larger, throughout, than in *effusa*, and have thicker walls. The radial corallites are larger, more unequal, and more prominent; the larger ones are more tubular, with thicker walls, and a more nearly terminal calicle. In *effusa* they are more obliquely truncated with a shorter inner lip and more oblique calicle.

Of course, a large series might serve to fill the gap between them, but for the present they seem as distinct as most of the related species. The types are both from Point Pedro, Ceylon.

Errata.

Page 184, line 6 from bottom, for *Millipora* read *Millepora*.

Page 222, line 19, add Pl. xxxvi. Fig. 22 ; and Pl. xxxvi B. Fig. 10.

Page 229, line 17, add Pl. xxxvi D. Fig. 11.

Page 244, line 8, omit Fig. 5*a* and 14*a*.

VI.—Some Spiders and Mites from the Bermuda Islands.

By Nathan Banks.

The following pages contain a list of some spiders and mites collected in the Bermudas by Prof. A. E. Verrill and some of his assistants. Most of them were gathered the past spring, 1901.*

Several of the spiders are immature, so that they cannot be fully determined. Three of the spiders are described as new. There are twenty-eight spiders in the list, which is more than twice as large as any previous list. They are distributed in sixteen families; the Theridiidæ, with six species, leads in point of numbers; eleven families are represented by but one species

John Blackwall recorded six species of spiders from the Bermudas in 1868.† They are as follows:

1. *Loxosceles rufescens* Lucas. +
2. *Epeira gracilipes* Blackw. +
3. *Thomisus pallens* Blackw. +
4. *Salticus diversus* Blackw.
5. *Heteropoda venatoria* Linn.
6. *Filistata depressa* Koch.

His *Epeira gracilipes*, which was originally described from Rio Janeiro, is probably the common *Epeira theisii* Walck. The *Filistata depressa* is the same as *F. hibernalis* Hentz; while his *Salticus diversus* is a synonym of *Plexippus paykulli* Aud. and Sav.

In 1889, Dr. George Marx reported on the spiders collected in the Bermudas by Prof. Angelo Heilprin.‡

He had twelve species, as follows:

1. *Uloborus zosis* Walck.
2. *Nephila clavipes* Koch.
3. *Cyclosa caudata* Hentz.
4. *Epeira labyrinthea* Hentz. +
5. *Theridium tepidariorum* Koch.

* These collections were made in April and May, 1898, and from March 10th to May 9, 1901. Probably many other species could be found in summer and autumn.—A. E. V.

† Notice of several species of Spiders supposed to be new or little known to Arachnologists. Ann. Mag. Nat. Hist. (4), ii, 1868, pp. 403–410.

‡ A contribution to the knowledge of the spider fauna of the Bermuda Islands, Proc. Acad. Nat. Sci., Philad., 1889, pp. 98–101, one plate. Heilprin's collection was made in midsummer. Prof. Verrill's in the spring. This may account for part of the difference.

6. *Argyrodes nephilæ* Tacz. +
7. *Pholcus tipuloides* Koch.
8. *Dysdera crocata* Koch.
9. *Plexippus paykulli* Aud.
10. *Tapinattus melanognathus* Lucas.
11. *Heteropoda venatoria* Linn.
12. *Lycosa atlantica* Marx.

Although in the present list there are many more species than in these two together, there are five species in these lists (indicated by +) which do not appear in the collections of Prof. Verrill. Adding these to the present list, we have a total of 33 spiders known from the Bermudas.

Three of Blackwall's list he considered new; the other three do not show anything as to the affinities of the fauna. Of Dr. Marx's twelve species, ten are found in the Southern United States, but most of these are widely distributed in the neotropical region. The present list will not uphold this affinity to the mainland, but indicates a relationship with the West Indian fauna.

Although Blackwall described three new species in his list, Dr. Marx one in his, and the writer three in this list, it is quite improbable that any of the species are peculiar to the islands; two of those here described are known to me from Hayti, and elsewhere in the West Indies.

FILISTATIDÆ.

Filistata hibernalis Hentz. Large Brown Spider.

Filistata hibernalis Hentz, Journ. Bost. Soc. Nat. Hist., iv, 227, pl. vii, fig 6, 1842.

Several specimens; a male from Walsingham, May 5; one specimen from Tucker's Island, 3 May, under stones. Known from the Southern United States, Mexico, Central America, and the West Indies. Nos. 2321, 2322, 2324, 2331–33.

SCYTODIDÆ.

Scytodes longipes Lucas.

Scytodes longipes Lucas, Ann. Soc. Ent. France, 1845, p. 71, pl. i, fig. 1.

Three specimens; a male from mouth of Tucker's Island cave, 3 May. Known from northern South America, Central America, and West Indies. Two specimens collected by Mr. T. G. Goslin in summer. Nos. 2319, 2343, 2360, 2408.

Scytodes fusca Walckenaer.

Scytodes fusca Walck., Aptères, i, p. 272, 1837.

One specimen from the entrance of Tucker's Island cave, 3 May. Distribution like that of the preceding species. Nos. 2355.

DYSDERIDÆ.

Dysdera crocata Koch.

Dysdera crocata Koch, Die Arach . v, p. 81, pl. clxvi, figs. 392, 393, 394, 1839.

Several specimens, one from Walsingham, 3 May, common under stones. Occurs in Europe and the Eastern United States. Nos. 2308, 2347.

OONOPIDÆ.

Oönops bermudensis, sp nov.

Cephalothorax, mandibles, sternum and legs pale yellow, the femora paler on bases, eyes on black spots; abdomen pale gray. Cephalothorax clothed with scattered black hair; central eyes short

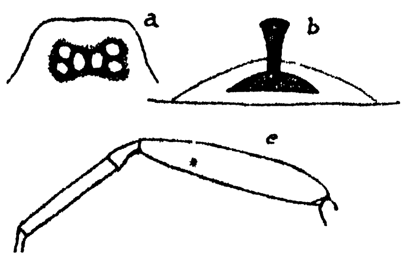

Figure 1.—*Oönops bermudensis*; *a*, eyes; *b*, epigynum; *c*, hind leg

elliptical, touching; lateral eyes round, equal, their point of touching opposite the middle of the central eyes; the eye-area plainly broader than long. Legs with black hair and reddish spines, quite long and slender, hind femora thickened and reaching the posterior third of the abdomen. Palpi with many short stout spines and a pair of longer spines under the bases of the tibia and tarsus. Abdomen once and two-thirds longer than broad; epigynum shows a transverse crescentic mark and from the middle in front is a clavate extension.

Length, 2^{mm}. No. 2340.

One specimen from the Bermudas, without more definite locality.

DRASSIDÆ.

Callilepis, sp.

One immature specimen of a dark-colored species, from mouth of Tucker's Island cave, 3 May. No. 2356.

CLUBIONIDÆ.

Corinna, sp

Several immature specimens from Hungry Bay, April. No. 2334

Hypsinotus, sp.

An immature specimen, very close to, and perhaps identical with *H. pumilis* Keys., from Porto Rico. No. 2309.

Anyphæna Verrilli, sp. nov.

Cephalothorax pale yellowish, darker in front, the clypeus and mandibles red-brown; sternum yellowish; legs pale, more red-brown on metatarsi and tarsi, especially of the anterior pairs. Abdomen above and below pale, above with many rows of darker hairs. The cephalothorax is rather short and broad; the A. M. E. scarcely diameter apart, rather closer to the equal A. S. E.; P. M. E. somewhat larger, nearly twice their diameter apart and about as far from the nearly equal P. S. E. Posterior eye-row strongly procurved, longer than the anterior eye-row. Mandibles rather large and hairy, but not porrect nor divergent, a little longer than the patella of leg I. Legs of moderate length, and quite densely spined. Ventral furrow about three-fourths the distance from the spinnerets to the lung-slits; abdomen about twice as long as broad, truncate at base.

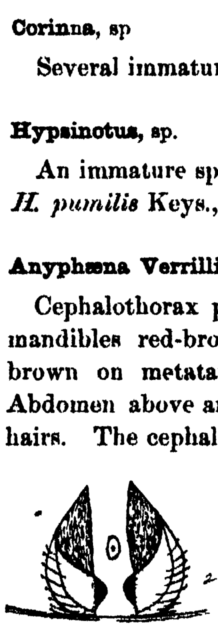

Figure 2.—*Anyphæna Verrilli*, epigynum.

Length ♀, 8.5mm.

One specimen from Walsingham, 3 May, 1901. I have also seen specimens from parts of the West Indies. No. 2346.

Eutichurus insulanus, sp. nov.

Cephalothorax dull brownish yellow, eyes on black spots; mandibles red-brown; sternum brownish yellow; legs pale greenish; abdomen pale gray, rather darker above than below, blackish around the spinnerets, the latter pale. The cephalothorax is rather

low and quite broad in front. The mandibles are large and gibbous above at base, plainly divergent, in front with many small granules from each of which arises a bristle. Posterior eye-row straight, a little longer than the anterior; all eyes subequal. A. M. E. less than their diameter apart, and as close to the equal A. S. E.; P. M. E. once and one-half their diameter apart, about diameter from the equal P. S. E. Legs moderately long, very hairy, with a few weak spines; two pairs under the tibiæ and metatarsi I and II; tibiæ III and IV below with one spine near base, one near middle, and a pair at tip, these metatarsi with three pairs below. Abdomen about once and three-fourths as long as broad, broadest behind the middle, rounded at base and tip, convex above; the superior spinnerets long, two-jointed, the apical joint tapering and as long as the basal; epigynum shows two oblique, elliptical openings, some distance apart.

Figure 3.—*Eutichurus insulanus*; epigynum.

Length ♀, 5.5mm. No. 2362.

One female from the Bermudas (without more definite locality) collected by W. G. Van Name, in May. It occurs also in Hayti.

DICTYNIDÆ.

Dictyna, sp.

One young specimen, without particular locality. No. 2367.

AGALENIDÆ.

Tegenaria derhami Scopoli.

Aranea derhami Scop., Entom. Carnioli., p. 400, 1763.
Tegenaria derhami Emerton, Trans. Conn. Acad., viii, p. 29, pl. vii, figs. 6, 6c; 1890.

Several specimens; one from Walsingham, 3 May; another preyed upon by *Plexippus paykulli*, 20 April. It is a cosmopolitan spider. Nos. 2326, 2327.

PHOLCIDÆ.

Pholcus tipuloides Koch.

Pholcus tipuloides Koch, Die Arachn. Australiens, p. 281, 1871.
Pholcus tipuloides Marx, Proc. Phil. Acad. Nat. Sci., 1889, p. 99, pl. iv, fig. 5.

Several specimens, some from Tucker's Island cave, 3 May. (It occurred at and within the entrance of the cave in considerable numbers.—A. E. V.). A cosmotropical species. Nos. 2315, 2316, 2320, 2361, 2409.

THERIDIIDÆ.

Theridium tepidariorum Koch.

Theridium tepidariorum Koch, Die Arach., viii, p. 75, figs. 647, 648, 1841.
Theridium tepidariorum Emer., Trans. Conn. Acad., vi, p. 18, pl. ii, fig. 1, 1882.

Four specimens collected by Mr. T. G. Goslin in summer. Nos. 2401, 2407. It is found in houses throughout the civilized world.

Theridium studiosum Hentz.

Theridium studiosum Hentz, Journ. Bost Soc. Nat. Hist., vi, p. 274, pl. ix, fig. 5, 1850

Two females from Walsingham, 3 May. Occurs in the Southern States, and Mexico. No. 2349.

Theridium rufipes Lucas.

Theridion rufipes Lucas, Explor. de l'Algèrie, Arachn., p. 263, pl. xvi, fig. 5, 1847.

One specimen, male, from mouth of Tucker's Island cave, 3 May. A common cosmotropical spider. No. 2354.

Lathrodectus geometricus Koch

Lathrodectus geometricus Koch, Die Arachn., viii, p. 117, pl. cclxxxiv, fig. 684, 1841.

Several examples; a pair from Paynters' Vale, 28 April; two females have their egg-cocoons. Known from South America, and the West Indies. Nos. 2323, 2352, 2353, 2363.

Bathyphantes, sp.

Two specimens, both immature; the sternum and venter are black, the dorsum of abdomen dark gray with a black herring-bone mark, legs pale, cephalothorax yellowish. No. 2338.

Erigone, sp.

One female, immature, abdomen and sternum black, mandibles rather prominent and diverging. No. 2335.

ULOBORIDÆ.

Uloborus geniculatus Olivier.

Araneus geniculatus Oliv., Ency. Meth., ii, p. 214, 1789.
Uloborus zosis Walck., Aptères, ii, p. 231, 1842.
Uloborus zosis Marx, Proc. Acad. Nat. Sci. Philad., 1889, pl. iv, fig. 1.

Several specimens received from Mr. T. G. Goslin, collected in summer. Nos. 2404, 2406. A widely distributed, cosmotropical spider.

EPEIRIDÆ.

Cyclosa caudata Hentz

Epeira caudata Hentz, Journ Bost. Soc. Nat. Hist., vi, p. 28, pl. iii, figs. 14, 14*a*, 14*b*, 1850.
Cyclosa conica Emerton, Trans. Conn. Acad., vi, p. 321, pl. xxxiv, fig. 3, 1884.

Various specimens, several from Walsingham woods, 3 May, on trees; two from Tucker's Island, 3 May. Distributed over the United States and Mexico. Nos 2339, 2350, 2358.

Argyroepeira hortorum Hentz. Silver Spider.

Epeira hortorum Hentz, Journ. Bost. Soc Nat. Hist., v, p. 477, pl xxxi, fig. 19, 1847.
Argyroepeira hortorum Emerton, Trans. Conn. Acad., vi, p. 332, pl xxxvii, figs. 29–32, 1884.

Three adults from Walsingham woods, 3 May, on trees ; several young specimens. Occurs in the eastern United States, Mexico, and the West Indies. No. 2330.

Nephila clavipes Fabricius. Silk Spider.

Aranea clavipes Fabr., Entom. Syst., ii, p. 420, 1775.
Nephila clavipes Koch, Die Arachn., v, p. 81, pl. clii, fig. 355, 1839

Several adults taken by Mr. T. G. Goslin, last summer. The largest has an expanse of 5.5 inches. This is the typical form, as is shown by Mr. F. O. P. Cambridge in a recent paper on spiders from the Bahama Islands (Ann. Mag. Nat. Hist., April, 1901, pp. 322–332).

Occurs along the South Atlantic coast, and the regions adjacent to the Carribean Sea.

(The adults are found only in late summer and autumn. It is mentioned by the earliest settlers, 1610–1615.—A. E. V.) Nos. 2314, young; 2399, adult.

SPARASSIDÆ.

Heteropoda venatoria Linn Great House Spider

Aranea venatoria Linn., Syst. Nat., Ed. x, p. 1037, 1758
Ocypete murina Koch, Die Arach., xii, p. 86, pl. ccccv, fig. 978, 1845.

Several specimens, one very young. A common cosmotropical spider, occurring in the extreme southern portions of the United States. (Found in outhouses and sometimes in dwellings. The largest are 4.50 inches across the outstretched legs. It is a very active running spider.—A. E. V.) Nos. 2305, 2306, 2317, 2342.

LYCOSIDÆ.

Lycosa atlantica Marx

Lycosa atlantica Marx, Proc. Acad. Nat. Sci., Philad., 1889, p. 100, pl. iv, fig. 4.

Several specimens; one from Hungry Bay, April, under stones; another from the mouth of Tucker's Island cave, May 3. It is very possibly the same as *Lycosa fusca* Keys., described from Cuba in 1877. Nos. 2307, 2325, 2357, 2405.

OXYOPIDÆ.

Oxyopes salticus Hentz

Oxyopes salticus Hentz, Jour. Bost. Soc. Nat. Hist., v, p. 196, pl. xvi, fig. 10, 1845.

Two immature specimens. Occurs from the southern United States to Brazil. No. 2345.

ATTIDÆ.

Wala vernalis Peckham Jumping Spider.

Anoka vernalis Peck., Proc. Zoöl. Soc. London, 1893, p. 701.
Anoka vernalis Peck., Occ. Pap. Nat. Hist. Soc. Wisc., vol. ii, no. 2, pl. xiii, fig. 8, 1894.

One female collected by Mr. T. G. Goslin in summer. No. 2410. Described from Jamaica, but now known from many parts of the West Indies.

Tapinattus melanognathus Lucas. Jumping Spider

Salticus melanognathus Lucas, Hist. Nat. d'Iles Canar., ii, p. 29, 1839.
Menemerus melanognathus Marx, Proc. Acad. Nat. Sci., Philad., 1889, p. 99, pl iv, fig. 8.

One specimen. A cosmotropical spider, found in Florida and California. No. 2313.

Plexippus paykulli Aud. and Sav Larger Jumping Spider.

Attus paykulli A. and S. Descrip. de l'Egypte, xxii, p. 172, 1827
Menemerus paykulli Marx, Proc Acad. Nat. Sci., Philad, 1889, p. 99, pl. ii, fig. 2.

A number of specimens; one feeding on a *Tegenaria derhami*, 20 April. A very common cosmotropical spider, not rare in the southern United States. Nos. 2310–12, 2359, 2402.

ACARINA.

Actineda agilis Banks. Mite.

Actineda agilis Bks., Trans. Amer. Entom. Soc., 1894, p. 211.

Two specimens, one from Castle Island, under stones, 24 April. Previously known only from the eastern United States. No. 2379.

Rhyncholophus, sp. Mite.

Two specimens of a small, undescribed species. No. 2380.

Holostaspis, sp.

Two specimens and one young, probably of the same species. The American forms of this genus have not been studied. No. 2381.

VII.—The Marine and Terrestrial Isopods of the Bermudas, with Descriptions of New Genera and Species.

By Harriet Richardson.

[Collaborator, Smithsonian Institution.]

1. *The Marine Isopods of the Bermudas, with descriptions of thirteen New Species and three New Genera.*

There is almost no literature relating to the Marine Isopods of the Bermudas.

In 1891 Ives* described and figured a new species of *Cymodocea* from the Bermudas (*C. bermudensis*), which has since been referred to the genus *Dynamene.*

Several species of wide-spread distribution have been recorded from the Bermudas, as for example, *Idotea marina* (Linnæus), specimens of which are in the Smithsonian Institution. It was taken in abundance by the Yale party in 1901, in Hamilton Harbor.

Spence Bate† mentions, without any description, a species of *Bopyrus* from the Bermudas, parasitic on *Latreutes ensiferus* (Milne-Edwards), which is without doubt, identical with *Bopyroides latreuticola* Gissler, found on the same host at Beaufort, North Carolina.

The material for the present paper is the result of three expeditions to the Bermudas; one in 1876–7, when Prof. George Brown Goode collected a number of Isopods; one in 1898, undertaken by Prof. A. E. Verrill and party; and another in the spring of 1901, by Prof. A. E. Verrill and Mr. A. H. Verrill.

These collections contain both known and unknown species. Among the known species are to be mentioned specimens of *Dynamene bermudensis* Ives, and *Idotea marina* (Linnæus), already recorded from the Bermudas.

Also specimens of *Corallana quadricornis* Hansen, *Alcirona krebsii* Hansen, *Nerocila acuminata* Schiœdte and Meinert, *Dynamene perforata* Moore, and *Cilicæa caudata* (Say), common to West

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* Proc. Philad. Acad. Nat. Sci., 1891, p. 194.

† Report of the Scientific Results of the Exp. Voyage of H. M. S. Challenger, xxiv, p. 582, 1888.

Indian waters; *Tanais cavolinii* Milne-Edwards, *Leptochelia rapax* Harger, and *Leptochelia dubia* (Krøyer), the first and last named of wide distribution, and all three common to the Northeast coast of America. These species have not been previously recorded from the Bermudas.

The thirteen new species herein described are representatives of the following families: *Apseudidæ*, *Anthuridæ*, *Cirolanidæ*, *Sphæromidæ*, and *Janiridæ*. Three are the types of new genera.

CHELIFERA or TANAIOIDEA.

Family Tanaidæ.

Tanais cavolinii Milne-Edwards.

Tanais cavolinii Milne-Edwards, in Audouin and Milne-Edwards, Précis d'Entomologie, i, pl. xxix, fig. 1, 1828; Hist. Nat. des Crust, iii, p. 141, pl xxxi, fig. 6, 1840

Tanais tomentosus Krøyer, Naturhist. Tidsskr, iv, p. 188, 1842; ibid (2) ii, p. 412, 1847; Voy en Scand., Crust., pl. xxvii, figs. 2a-q, 1849. Lilljeborg, Öfvers. Vet.-Akad. Forh., Årg., viii, p 23, 1851. Meinert, Crust Isop. Amph. Dec. Danaiæ, p 86, 1877.

Crossurus vittatus Rathke, Fauna Norwegens, p. 39, pl. 1, figs. 1-7, 1843

Tanais hirticaudatus Bate, Rep. Brit Assoc., 1860, p. 224, 1861.

Tanais vittatus Lilljeborg, Bidrag Känn Crust. Tanaid, p. 29, 1865 Bate and Westwood, Brit. Sess. Crust., ii, p 125, 1868. Stebbing, Trans. Devon. Assoc., 1874, p. 7, and 1879, p. 6; Ann. Mag. Nat. Hist., (4) xvii, p 78, 1876. Verrill, Am. Jour. Sci (3), x, p. 38, 1875. Harger, Proc. U. S. Nat. Mus., ii, p. 162, 1879; Rep. U. S. Fish Comm., pt. 6, p. 418-419, pl. xiii, figs. 81-82, 1880.

Tanais tomentosus G. O. Sars, Crust. of Norway, ii, pt. i, ii, p. 12, pl. v, 1896.

Tanais Cavolinii Dollfus, Bull. Soc. Zoöl. de France, xxi, p. 207, 1897; Mém. de la Soc. Zoöl. de France, xi, p. 35, 1898. Norman, Ann. Mag. Nat Hist. (7), iii, pp. 332-333, 1899. (See Norman for synonymy and full reference.)

Hab. Castle Harbor, Bermudas, in dead coral, collected by A. E. Verrill and party.

Also found at Noank, Conn.; Long Island Sound; Greenland; west coast of Norway; British Isles; West France; Azores. Depth, 1-6 ft. (Verrill).

Leptochelia dubia (Krφyer).

Tanais dubius Krφyer, Naturh. Tidssk , iv, p. 178, pl. ii, figs. 20–22, 1842–3.
Paratanais algicola Harger, Am. Jour. Sci. and Art, xv, p. 377, 1878.
Leptochelia algicola Harger, Report U. S. Fish Com., pt. 6, p. 421, 1880.
Leptochelia dubia G. O. Sars, Archiv for Math. og Naturvid., p. 26, 1880; and p. 317, pl. x, xi, 1886.
Leptochelia algicola Dollfus, Mém. de la Soc. Zool. de France, xi, p. 44, 1898.
Leptochelia dubia Norman, Ann. Mag. Nat. Hist. (7), iii, p. 334, 1899.
?*Leptochelia incerta* Moore, Report U. S. Fish Com., ii, p. 165–166, 1901.

There are two males and a small number of females in the collection. The males and females agree with the original description and figures of *L. dubia* (Krφyer), the inner branch of the uropoda in both sexes consisting of five joints.*

There are also two specimens in the collection, both females, which have the inner branch of the uropoda two jointed. Although this may be a new species of *Leptochelia*, I do not feel warranted with such scanty material, and with no males, to describe a new species of this genus.

Hab. Castle Harbor, Bermudas, collected by A. E. Verrill and party, in 1898. Also Jersey; Birterbuy Bay, Ireland; Falmouth Harbor; Valentia, Ireland; Mediterranean; Atlantic coast from Brittany to Senegal and Teneriffe; Northeast coast of N. America; Brazil.

Leptochelia rapax Harger.

Leptochelia rapax Harger, Proc. U. S. Nat. Museum, ii, p. 168, 1879. Report U. S. Fish Comm., pt. vi, p. 424, pl. xiii, figs. 89, 90, 1880.

Hab. Bermudas, collected by W. G. Van Name, May, 1901.

Also found at Annisquam, Mass., in 3 feet of water, on muddy bottom.

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* There is no character of specific importance to separate *L. algicola* Harger from *L. dubia* (Krφyer) the males and females of *L. dubia* in the collection from the Bermudas agreeing with Harger's specimens as figured and described, with the exception that the Bermudian specimens have five joints to the inner branch of the uropoda instead of six. Stebbing has pointed out (Ann. Mag. Nat. Hist. (6) xvii, p. 158–159, 1896) that there is some variation in the number of joints in several species of *Leptochelia*, and *L. Edwardsii*, which Krφyer figures and describes as having seven joints to the inner branch, is now recognized as a synonymy of *L. savignyi*, which is figured and described by the same author as having six joints. It is not improbable, as Stebbing has suggested, that *L. savignyi* and *L. dubia* are identical.

Family Apseudidæ

Apseudes triangulata Richardson, sp nov

PLATE XXXVII FIGURES 1 5

Body narrow, elongated, surface smooth.

Head with frontal margin produced at the middle in a rostrum like a spear point, whose sides near the base are excavated below the lateral expansion of the rostrum. On either side of the excavation thus formed the margin is acutely produced in a small anterior process. Lateral to this process is the ocular process, which is produced anteriorly about the same distance. The eyes are distinct and black and occupy almost the whole surface of the ocular lobe.

The first pair of antennæ have the first joint of the peduncle long, the inner lateral margin of which is armed with three long spines and one small one; the outer margin, with one large spine near the apex. The second joint is one-third the length of the first joint and is unarmed. The third joint is one-half as long as the second joint. The flagellum is composed of about fourteen joints; the secondary appendage of about seven joints. The peduncle of the second pair of antennæ extends to the end of the first joint of the peduncle of the first pair, and has an exopod developed at the base of the third joint. The flagellum is composed of about ten joints, and extends about half the length of the flagellum of the first pair of antennæ. There is a prominent spine on the epistoma.

The first free segment of the thorax is shortest, the two following ones being longer, the next two the longest, and the last but little longer than the first The first segment is as wide as the head, the others decrease in width gradually. The antero-lateral margins of all the segments except the first are produced into one acute process, of the fourth and fifth free segments into two acute processes. The last segment bears a ventral spine.

The abdominal segments gradually decrease in width backwards. The sixth or terminal segment is produced on either side near the base into two acute processes. Beyond the last process the segment widens slightly for the attachment of the uropoda, and ends posteriorly in a triangular process. The uropoda are very long, the inner branch being half the length of the body, and composed of about twenty-five joints. The outer branch is composed of seven joints.

First gnathopods with the upper distal margin of the propodus, finely serrate and armed with a tooth near the articulation of the

dactylus. Second gnathopods have the merus armed with one spine at its distal extremity on the posterior margin, and one on the anterior margin; the carpus armed with two spines on its posterior and one on the anterior margin at the distal extremity; the margin of the propodus armed with three spines on the posterior margin, and one large spine and one small one at the distal extremity on the anterior margin. The dactylus is serrate on its inner margin. Exopods are present on both first and second gnathopods. The other legs are beset with spines.

The specimen is a female and has a large marsupium filled with eggs, extending the length of the first four free segments of the thorax.

Only one individual was collected by A. E. Verrill and party, in Harrington Sound, Bermudas.

Type specimen in Peabody Museum, Yale University. Cat. No. 3192.

Apseudes propinquus Richardson, sp nov

PLATE XXXVII FIGURES 6–9

Body narrow, elongated, surface smooth.

Head with frontal margin produced in the middle in a long, acute, deflected process, from base of which on both sides there is an abrupt lateral expansion, the margin forming an outward curve which extends to the base of the ocular lobe and then proceeds straight to the lateral margin of the head. Ocular lobe produced in an acute process. Eyes large, black, occupying the whole of the ocular lobe.

First pair of antennæ with first joint of peduncle long, and armed on inner lateral margin with two large spines and one small one near the base, and on distal end of outer margin with one large spine. Second joint less than one-third the length of first joint and unarmed. Third joint one-half as long as second joint. Flagellum composed of sixteen joints. Secondary appendage composed of eight joints. Second pair of antennæ with an exopod at base of third joint of peduncle; flagellum composed of ten joints. There is a conspicuous spine on the epistoma.

First two free segments of the thorax about equal in length, the three following ones longer, increasing in length, the last segment a little longer than the first two. The antero-lateral margins of all the segments are acutely produced, those of the fourth and fifth free

segments have two antero-lateral angulations. There is an anteriorly directed curved spine on the ventral surface of the first free segment. On the ventral surface of the second segment there is a straight spine directed posteriorly. The third, fourth, and fifth segments bear each a ventral curved spine directed anteriorly. The sixth segment has on the ventral surface a large, stout process.

The lateral margins of all the first five abdominal segments are drawn out in acute processes.

The terminal segment has two lateral angulations above the attachment of the uropoda. The posterior margin is triangulate. The inner branch of the uropoda is very long, equal in length to half the body, and is composed of thirty-four joints. The outer branch consists of eleven joints.

The first gnathopods have a tooth on the distal margin of the propodus near the articulation of the dactylus. There is a conspicuous spine on the posterior margin of the basis.

The second gnathopods have one spine at the distal end of the merus on the anterior margin; one spine at the distal end of the carpus on the anterior margin and two spines on the posterior margins of the same joint; four spines on the posterior margin of the propodus and two on the anterior margin at the distal extremity; the dactylus is serrate along the inner margin. Exopods are present on both first and second gnathopods. The other legs are beset with spines.

A few specimens, both males and females, were collected by A. E. Verrill and party at Bailey Bay and Castle Harbor, Bermudas, in 1898.

Type specimen from the Bermudas in Peabody Museum, Yale University. Cat. No. 3194.

This species is very closely related to *Apseudes intermedius* Hansen* but differs in the following points.

1.—The first joint of the peduncle of the first pair of antennæ is armed with three spines on the inner margin, and one spine on the outer margin at the distal end. In *A. intermedius*, this joint is unarmed.

2.—In the increased number of joints in the flagella of both pairs of antennæ, there being sixteen joints in the flagellum of the first pair of antennæ, eight in the secondary appendage, and ten in the flagellum of the second pair of antennæ, while in Dr. Hansen's spe-

* Isopoden, Cumaceen, und Stomatopoden der Plankton-Expedition, p. 49–50, pl. v, fig. 10–10b, pl. vi, fig. 1, 1895.

cies the flagellum of the first pair of antennæ is composed of seven joints, the secondary appendage of three joints, and the flagellum of the second pair of antennæ of four joints.

3.—In the much greater length of the uropoda, the inner branch of which in *A. propinquus* is half the length of the body and composed of thirty-four joints, the outer branch consisting of eleven joints, while in *A. intermedius* the outer branch has only four joints, and the inner branch is only twice the length of the terminal abdominal segment and is composed of only fifteen joints.

Parapseudes goodei Richardson, sp nov.

PLATE XXXVII. FIGURES 10-14

Surface of body smooth; color light yellow.

Head but slightly narrowed anteriorly. Eyes with large, brown ocelli and placed on ocular processes, articulated to the head. Frontal margin with a rostrum projecting between the basal joints of the first pair of antennæ. The base of the rostrum is constricted, the anterior margin broadly rounded.

The first pair of antennæ have the peduncle short, the first joint twice as long as the second, the third half as long as the second, all three with margins smooth, unarmed, but fringed with long hairs. The flagellum consists of seven joints; the secondary appendage of four joints. The second pair of antennæ extend only to the end of the peduncle of the first pair; the flagellum contains five joints; a scale is articulated to the peduncle.

The first, second and third free thoracic segments are about equal in length, the following three being longer than the first three, and sub-equal. The first and second segments have a small epimeral lobe on the antero-lateral margin. The third segment has a small lobe about the center of the lateral margin. The lobes of the three following segments are situated post-laterally.

The abdomen is very short; all the segments together not equalling in length the last two thoracic segments. The first five segments have the margins produced at the sides, with deep lateral incisions between the segments.

The terminal segment is triangulate posteriorly with the apex acute. The uropoda are quite half the length of the body; the inner branch consisting of about twenty-five joints, the outer and smaller branch consisting of six joints. There are but four pairs of pleopoda.

The first pair of legs of the female are much more slender than those of the male. In the male there is a deep excavation on the distal margin of the propodus near the articulation of the dactylus, while in the female this excavation is comparatively small. In the male there is a spine within this excavation and one on the dactylus, both situated at the articulation of the dactylus and the propodus. Exopods are present on both pairs of gnathopods. All the other legs are very spinulose

A few specimens (types) were collected by A E. Verrill and party in 1898, at Castle Harbor, Bermudas, and one specimen was collected by G. Brown Goode at the Bermudas in 1876-7.

Type in Peabody Museum, Yale University. Cat. No. 3222.

This species has a close resemblance to *Parapseudes latifrons* (Grübe),* but differs in the following characters: in *P. goodei* the first pair of gnathopods are more robust ; the propodus has a deep excavation near the articulation of the dactylus, within which is a large spine. There is also a spine on the dactylus.

The rostrum is constricted at the base in *P. goodei*, while in *P. latifrons* the line is unbroken from the apex of the rostrum to the lateral margin of the head.

The secondary appendage of the flagellum of the first antennæ is composed of four joints in *P. goodei* while in *P. latifrons* this appendage is composed of seven joints. The flagellum of the second pair of antennæ consists of five joints in *P. goodei*, while in Grübe's species it consists of eight joints.

FLABELLIFERA or CYMOTHOIDEA.

Family Anthuridæ.

Paranthura infundibulata Richardson, sp. nov

PLATE XXXVIII. FIGURES 15-20.

♂. Body narrow, elongate ; color yellow, with markings of black. Head with antero-lateral angles prominent, between which the frontal margin is excavate for the reception of the antennæ, the middle being produced in a conspicuous median point. The eyes are situated in the antero-lateral prolongations.

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* *Rhoëa latifrons* Grübe, Die Insel Lussin und ihre Meeresfauna, p. 75, 1864. *Parapseudes latifrons* G O Sars, Archiv for Math. og Naturvidenskab, Vol. xi, p. 304, pl. viii, 1886.

The first pair of antennæ have the basal joint long, oblong in shape, the other two joints of the peduncle being short and about equal in length; the flagellum consists of nine joints.

The second pair of antennæ have the second joint of the peduncle very long, slightly exceeding in length the first and second peduncular joints of the first pair of antennæ. The second antennæ are geniculate at the articulation of the second and third joints. The other three joints, following the second, are of nearly equal length. The flagellum consists of a single tapering joint, furnished with hairs.

The first three thoracic segments are about equal in length, elongate, the first two having their posterior angles rounded. The fourth, fifth and sixth segments are equal in length, and one-third shorter than the first three. The seventh segment is about half as long as the preceding one, and has the posterior angles produced downwards.

The segments of the abdomen are distinct, and very short, all five anterior to the terminal segment being no longer than half the length of the seventh thoracic segment. The terminal segment is long and narrow, of the same width throughout its length, except at the apex, where the lateral margins are abruptly drawn out into processes, which curve upwards, giving a funnel-shaped appearance to the posterior end of the segment, which is very concave. The posterior margin is truncate and coarsely denticulate.

The inner branches of the uropoda do not quite reach the extremity of the terminal abdominal segment. The basal joint is about half the length of the terminal abdominal segment. The inner branch is extremely concave, with its entire margin denticulate, its ventral surface having a longitudinal carina. The outer and superior branch is long and narrow, quadrangular and somewhat narrowed posteriorly, and from the middle slightly curving upward, coarsely denticulate on its inner lateral and posterior margin, the teeth being rather widely separated. The branches of the uropoda and the terminal abdominal segment are fringed with hairs.

The first, second and third pairs of legs are sub-cheliform. The second and third pairs have the propodus similar in shape to the first pair, but more slender and armed on their posterior margin with seven or eight large conspicuous spines. The other legs are longer and more slender, and armed with four spines on the anterior margin of both the carpus and the propodus.

A number of specimens, all males, were collected by George Brown Goode in 1876–7, at the Bermudas.

Type specimens in Peabody Museum, Yale University. Cat. No. 3207.

Paranthura verrillii Richardson, sp nov

PLATE XXXVIII FIGURES 21–22

Body narrow, elongate. Color dark brown, with scattered black dots.

Head with lateral angulations prominent, rounded, between which the front is excavate on either side of a small median point. Eyes large, situated in the lateral angulations.

First pair of antennæ have the first joint of the peduncle oblong, the other two shorter and about equal in length, flagellum six to seven jointed. The second pair of antennæ have a five-jointed peduncle, (the first joint being short and indistinct,) of which the second and fifth joints are longest, the flagellum being consolidated into a single, flattened, tapering joint, furnished with hairs.

The first five thoracic segments are of equal length. The sixth is somewhat shorter than any of the others, and the seventh is half as long as the sixth

The abdominal segments are distinct, the first five taken together being no longer than the seventh thoracic segment. The terminal abdominal segment is long and narrow, rectangular in shape, with margins entire. The basal joint of the uropoda is half as long as the terminal segment of the abdomen; the inner branch is rectangular, coarsely denticulate, and reaches the apex of the telson. The outer superior branch is narrow, elongate, rectangular, with margins coarsely denticulate, the teeth being close together.

The branches of the uropoda and the terminal abdominal segment are fringed with long hairs

The first three pairs of legs are sub-chelate. The second and third pairs have the posterior margin of the propodus armed with spines, as in the preceding species. In the following four pairs of legs the anterior margin of the propodus is armed with four spines.

A single female was collected by A. E. Verrill and party in 1898, at the Bermudas. Depth, 1–2 feet.

Type specimen in Peabody Museum, Yale University. Cat. No. 3186.

Colanthura Richardson, gen nov.

Body narrow, elongate. First pair of antennæ composed of four joints, the last joint being the flagellar joint. Second pair of antennæ composed of five joints, the terminal joint fringed with hairs.

The first six segments of the thorax large, the seventh very short, abruptly narrower than the sixth, not as wide as the abdominal segments and devoid of legs.

The first three pairs of legs are sub-chelate, the three following pairs ambulatory.

The abdominal segments are well defined and distinct from one another. The terminal abdominal segment is rounded, entire. The inner branch of the uropoda is likewise rounded; the outer and superior branch arches over the telson.

This genus agrees with both *Hyssura* Norman and Stebbing and *Cruregans* Chilton in the absence of the seventh pair of legs, but differs from the first named in the structure of the antennæ, both pairs of antennæ in *Hyssura* having multi-articulate flagella; in the structure of the outer branch of the uropoda, which in *Hyssura* does not arch over the telson; and in the structure of the mouth parts. *Colanthura* differs from *Cruregans* in the presence of eyes, which are wanting in *Cruregans*, and in the structure of the outer branch of the uropoda, the outer branch in *Cruregans* being very narrow and not arching over the squamiform telson, while in *Colanthura* the outer branch is broad and arches over the rounded terminal segment. The structure of the mouth parts is the same as found in the genera *Paranthura*, *Calathura* and *Cruregans*.

Colanthura tenuis Richardson, sp. nov.

PLATE XXXVIII. FIGURES 23-28.

Body narrow, elongate; surface smooth; color light yellow. Head with a prominent median process extending between the first pair of antennæ. Antero-lateral angles prominent, produced, reaching the distal end of the first joint of the peduncle of the first pair of antennæ. Eyes large, conspicuous.

First pair of antennæ consist of four joints, the terminal or flagellar joint being fringed with long hairs. The second pair of antennæ are composed of five joints, the terminal joint being fringed with hairs.

The first three thoracic segments are about equal in length. The fourth and fifth segments are each much longer than any of the

three preceding segments, and are about alike in size. The sixth segment is short, not quite as long as any one of the first three segments. The seventh is very short, being one-third the length of the sixth segment, and in both specimens examined is devoid of legs.

The segments of the abdomen are distinct, the first five together not being as long as the sixth thoracic segment. The last thoracic segment is abruptly narrower than the sixth, and is likewise somewhat narrower than the abdominal segments.

The terminal segment of the body is linguiform, the posterior margin evenly rounded and smooth. The inner branch of the uropoda is likewise rounded posteriorly with a smooth margin. The outer and superior branch arches over the telson. Both branches, as well as the terminal abdominal segment, are fringed with hairs.

The first pair of legs are cheliform, the propodus unarmed. The second and third pairs are also cheliform, but smaller, with the propodus armed on the posterior margin with five spines. The three following pairs of legs are ambulatory in character. The seventh pair are wanting.

Two specimens were collected by A. E. Verrill and party at the Bermudas in 1898. Both specimens are adult females, the marsupium in one being very large and extending the entire length of the thorax, from the second segment.

Type specimen in Peabody Museum, Yale University. Cat. No. 3252.

Anthelura affinis Richardson, sp. nov.

PLATE XXXVIII. FIGURES 29–32.

Body narrow, elongate. Head with small median point. Eyes distinct, situated in antero-lateral angulations.

Antennæ of both pairs with flagella consisting of several joints, and fringed with long hairs at the tip. Maxillipeds consist of five joints.

First three thoracic segments about equal in length. Three following segments somewhat longer, and sub-equal. Seventh segment fully half the length of preceding segment.

All the segments of the abdomen distinctly defined. Terminal segment narrowly linguiform, roundly triangulate at the apex and with smooth margins.

Outer superior branch of uropoda long, oval, reaching quite to the extremity of the terminal abdominal segment, and arching over the telson. Inner branch with posterior margin widely rounded and

extending beyond telson. Both branches have the margins smooth, entire.

First gnathopods with small hand. Dactylus short. Free inner margin of propodus furnished with hairs. Second gnathopods and first periopods similar in shape to, but smaller in size than, first pair of gnathopods. The free inner margin of the propodus is beset with two spines, the carpus with one spine. The remaining periopods have a single spine at the distal margin of the propodus and two spines on the carpus.

One specimen, a female, was collected by A. E. Verrill at the Bermudas in 1901.

Type in Peabody Museum of Yale University. Cat. No. 3349.

This species differs from *A. elongata* Norman, in the shape of the outer branch of the uropoda, in the length of both branches, as compared with the terminal abdominal segment, and in the fact that the margins of the outer branch in our species are smooth and not crenulate, as in *A. elongata*.

Family **Cirolanidæ.**

Colopisthus Richardson, gen. nov.

Head transversely elongated. Eyes situated in the middle of the lateral margins at the extreme edge and elevated knob-like above the surface.

Both pairs of antennæ short; second pair reach the posterior margin of the first thoracic segment.

First five abdominal segments consolidated into one short segment. Terminal segment strongly keeled in the median longitudinal line

Colopisthus parvus, Richardson, sp. nov.

PLATE XXXVIII. FIGURES 33–36.

Head transversely elliptical, the anterior and posterior margins rounded. The eyes are situated in the middle of the lateral margins at the extreme edge, and are elevated above the surface of the head like knobs. The head is concave between the eyes.

The first pair of antennæ are short, not much longer than the width of the head, and reach the end of the last peduncular joint of the second pair of antennæ; the flagellum contains three joints.

The second pair of antennæ are also short, extending to the posterior margin of the first thoracic segment; flagellum consists of seven joints.

The first thoracic segment is longest. The others are sub-equal with well defined epimera.

The first five abdominal segments are all coalesced into one segment. The terminal segment is triangular and strongly keeled along the median longitudinal line.

The inner branches of the uropoda extend beyond the tip of the terminal segment, are broadly oval and fringed with hairs. The outer branches are narrowly oval, about half as wide as the inner branches, and shorter.

Color light yellow, with numerous black dots.

About seven specimens were collected by A. E. Verrill and party at Bailey Bay, Bermudas, in 1898. Found at low water in corallines. Others were collected in 1901 at Waterloo, on Castle Harbor, Bermudas.

Type specimen from the Bermudas in Peabody Museum, Yale University. Cat. No. 3179.

Family **Corallanidæ.**

Corallana quadricornis Hansen.

Corallana quadricornis Hansen, Vidensk. Selsk. Skr (6), natur. og math. Afd., v, p. 382, pl. vii, fig. 2, 1890.

Hab. Bermudas, at the Flatts; at Long Bird Island in the cavities of a massive, black keraotsc sponge, living on the grassy sand-flats at low tide; Castle Harbor, in the same sponge. Also St. Thomas, West Indies.

Family **Alcironidæ.**

Alcirona krebsii Hansen

Alcirona krebsii Hansen, Vidensk. Selsk. Skr. (6), natur. og math. Afd., v, pp. 391–393, pl. viii, figs. 1–19, 1890.

PLATE XXXVIII. FIGURES 38*a*, 38*b*.

Hab. Castle Harbor, Bermudas, in the cavities of living bathing sponges and in dead coral. Two specimens (No. 33, 34) were taken from the fins of a Hamlet Grouper, in May;* St. Thomas, West Indies.

* The colors of these, in life, were as follows: Ground color, pale flesh-color; head and tail, yellowish brown; seven transverse, irregular bands of yellowish brown, those of the middle of the body with two points projecting forward, so as to show a tendency to form two dorsal lines of brown. A. E. V.

Family **Cymothoidæ.**

Nerocila acuminata Schiœdte and Meinert.

Nerocila acuminata Schiœdte and Meinert, Naturhist. Tidsskr., xiii, pp. 48–50, pl. iii, figs. 5–6, 1881–83.

Hab. Bermudas, collected by George Brown Goode in 1876-7. Also recorded from Beloxi, Miss.; St. Anna, Mexico; Fort Macon, North Carolina.

Family **Sphæromidæ.**

Cilicæa caudata (Say).

Nesea caudata Say, Jour. Phil. Acad, i, p. 482, 1818 Milne-Edwards, Hist. Nat. des Crustacés, iii, p. 219, 1840.

Cymodocea caudata Ives, Proc. Phil. Acad. Nat. Sci., p. 188, pl. vi, figs. 11–14, 1891.

Cilicæa caudata Richardson, Proc. U. S. Nat. Museum, xxiii, p. 586, 1901.

Hab. Bermudas, at Harrington Sound, Castle Harbor, and the Flatts. Also Egg Harbor, N. J.; Beaufort, N. C.; No Name Key, Fla.; between Salt Pond Key and Stock Island; Key West, Fla.; Sugarloaf Key, Fla.; N. W. end St. Martin's Reef, Fla.; Sarasota Bay, Fla.; off Progreso, Yucatan.

Found on the surface; also at the depth of 1 to 12 feet.

Dynamene bermudensis (Ives).

Cymodocea bermudensis Ives, Proc. Phil Acad. Nat. Sci., p. 194, pl. vi, figs. 15, 16, 1891.

Hab. Bermudas. Also Punta Rassa, Fla.; Cedar Keys, Fla.; Key West, Fla; No Name Key, Fla.; Sarasota Bay, Fla.; Beaufort, N. C.

Dynamene perforata Moore.

Dynamene perforata Moore, Report U. S. Fish Com., ii, pp. 173–174, pl. x, figs. 9–19, 1901.

PLATE XXXIX. FIGURE 39.

Head broader than long; eyes situated post-laterally. First pair of antennæ with the first two peduncular joints large, the second half as long as the first; the third joint long and slender, twice as long as second joint; flagellum consists of seven joints. The first two peduncular joints of the second pair of antennæ are of equal length; the following three of equal length and longer than the first two; the flagellum consists of about seven joints, and extends to the posterior margin of the third thoracic segment.

The thoracic segments are of equal length, with the exception of the first, which is slightly longer. The seventh segment is produced

backwards in two rounded lobes, one on either side of the median line, and close together.

The first abdominal segment has two suture lines at either side, indicative of coalesced segments. The terminal segment is very convex at the base, and has four small tubercles, forming a square on the convexity. Its apex has a heart-shaped opening, formed by the prolongation of the lateral margins, which prolongations meet anteriorly, and are divergent posteriorly, so that a triangular excavation is formed on the posterior end of the segment immediately below the heart-shaped opening.

The two branches of the uropoda are similar in shape and size. They are large, very much expanded, rounded posteriorly, with margins distinctly crenulate or denticulate, and extend some distance beyond the tip of the terminal abdominal segment.

The color is brown, with markings of black. Surface smooth, with the exception of the abdomen, which is very granular.

A number of specimens (13) were collected by George Brown Goode in 1876–7, at the Bermudas.

Several specimens differ from the specimen described in not having the 7th thoracic segment produced in lobes, and are without the four small tubercles at base of terminal segment. Several differ in having the uropoda not longer than the terminal segment.

The females do not have the heart-shaped opening in the terminal segment.

Specimens described are in Peabody Museum, Yale University. Cat. No. 3204.

The above species was described and figured as new, but the manuscript had not been sent to print when Mr. Moore's Report on the Porto Rican Isopoda was published, in which he described *Dynamene perforata*.

It was thought best to publish the author's description and figures, for although in the text Mr. Moore mentions the fact that the uropoda are serrate or crenulate, he does not show this in his drawings. The figures published here bring out this point.

Sphæroma crenulatum Richardson, sp. nov.

PLATE XXXIX. FIGURE 40.

Surface of body smooth. Color, light brown, with markings of black.

Head rounded in front with small median point, on either side of which is small excavation. Eyes situated post-laterally.

First pair of antennæ with the first joint of the peduncle long; second joint half as long as first; third joint equal in length to first; flagellum of five joints reaches the post-lateral margin of the head.

Second pair of antennæ extend to the middle of the first thoracic segment.

Thoracic segments subequal. Lateral margins straight. Epimera distinctly separated from segments.

First abdominal segment long, a little longer than any of the thoracic segments, with two suture lines. Terminal segment very convex, surface smooth, posterior margin widely rounded. Uropoda not extending beyond tip of terminal segment. Inner branch somewhat pointed at its extremity, margin smooth. Outer branch widely rounded and crenulate on the posterior edge.

Legs similar, all ambulatory, with small curved dactyli.

A number of specimens were collected at the Bermudas in 1876-7, by George Brown Goode.

Type in Peabody Museum, Yale University. Cat. No. 3250.

VALVIFERA.

Family **Idoteidæ.**

Idotea marina (Linnæus).

Oniscus marinus Linnæus, Fauna Suecica, p. 500, 1761; Syst Nat. (ed. xii), p. 1060, 1766.

Oniscus tridens Scopoli, Entom. Carniolica, p. 415, 1763.

Oniscus balticus Pallas, Spic. Zoöl. (9), p. 67, pl. iv, fig. 6, 1772.

Stenosoma irrorata Say, Journ. Acad. Nat. Sci. Philad., i, p. 423, 1818.

Idotea tricuspidata Desmarest, Dict des Sci. Nat., xxviii, p. 373, pl. xlvi, fig. 11, 1823.

Idotea irrorata Milne-Edwards, Hist. Nat Cr., iii, p. 132, 1840. Verrill and Smith, Invert. Vineyard Sd., pp. 22, 375, pl. v, fig. 23, from Report U. S. Comm. Fish and Fisheries, i, pp. 316, 569, 1873. Harger, Rep. U. S. Fish Comm., pt. 6, p. 343, pl. v, fig. 24-26, 1880.

Idotea marina Miers, Journ. Linn. Soc. Lond., xvi, p. 25-31, 1883. (See Miers for synonymy.)

Hab. Bermudas, at the Flatts Inlet, collected by A. E. Verrill and party. Also British Isles; Kattegat; Baltic; Dutch coast; coast of France; Mediterranean; Black and Caspian Seas; Atlantic coast of North America, from Nova Scotia and the Gulf of St. Lawrence to North Carolina. South America at Desterro and Rio Janeiro, Brasil; New Zealand; Red Sea; Java.

ASELLOTA or ASELLOIDEA.

Family Janiridæ.

Carpias Richardson, gen nov

Head without rostrum; frontal margin straight. Both pairs of antennæ multi-articulate; the second pair much longer than the body, and with a scale-like appendage articulated to the peduncle. Uropoda long, much longer than abdomen.

The first pair of legs in the male are prehensile and remarkably long, being one and two-thirds times the length of the body; are greatly enlarged distally, forming a broad club-like hand armed with triangular processes, to which is articulated a moveable finger, the propodus, likewise armed with triangular processes.

The ambulatory legs are simple, biunguiculate, and are of normal structure.

Carpias bermudensis Richardson, sp. nov

PLATE XXXIX. FIGURES 42–45   PLATE XL. FIGURE 41.

Surface of body smooth. Color yellow, with odd shaped markings of black.

Head narrower than first thoracic segment, with lateral margins rounded, entire. Frontal margin straight, antero-lateral angles not produced, rounded. Eyes large, with many ocelli, and situated on the lateral margins of the head.

The first pair of antennæ have the basal segment of the peduncle enlarged, the next two segments successively narrower, all about equal in length; the flagellum is multi-articulate, composed of about fourteen joints. The second pair of antennæ have a scale-like appendage outside of the third joint; the fourth and fifth joints are long, the fifth a little longer than the fourth; the flagellum is much longer than the body, and is composed of about one hundred joints.

The first thoracic segment is wider than the head; the lateral margins are straight, entire. The second and third segments have the lateral margins excavate, the anterior and posterior angles produced, with the epimeron situated in the excavation. The fourth segment has the anterior angle produced, the epimeron being situated in the excavation of the entire posterior part of the segment. The fifth, sixth and seventh segments have the lateral margins entire, the epimeron showing at the posterior part of the segment.

The terminal segment of the body is about as broad as long, the entire margin smooth, with a small rounded lobe between the basal joints of the uropoda.

The uropoda are very long, much longer than the abdominal segment. The basal joint is about two-thirds the length of the abdominal segment, and is narrower at the base than at the apex. The two branches are of nearly equal length, the outer one being slightly shorter, and are longer than the basal joint.

The first pair of legs in the male are remarkably long, being one and two-thirds times the length of the body, and are prehensile. The basis is as long as the width of the first thoracic segment, and has the distal end very much enlarged and inflated. The ischium is not more than half the length of the basis. The merus is a little longer than the basis, and is enlarged at its distal end. The carpus is very much elongated, is longer than the ischium, is greatly enlarged distally, and has its upper distal margin armed with three large triangularly-shaped processes. The propodus has the inner surface armed with two long, sharp triangular processes, its distal end being widely expanded and rounded on the inner surface. The dactylus is biunguiculate.

The other legs are of normal structure, ambulatory in character, and biunguiculate. In the female the first pair of legs are similar in structure and size to the other legs.

A number of individuals were collected by George Brown Goode at the Bermudas.

Type specimens in Peabody Museum, Yale University. Cat. No. 3203.

Stenetrium stebbingi Richardson, sp. nov.

PLATE XXXIX. FIGURES 46–49.

Body long, narrow, depressed. Color light yellow, with markings of black.

Head narrowed posteriorly, widening anteriorly; the antero-lateral angles produced into narrow acute processes, curving slightly inward; the anterior margin is produced in a rostrum, which is truncated, on either side of which is a triangular process. Eyes obliquely situated on the anterior portion of the head.

First pair of antennæ are placed between the two triangular processes and the rostrum; the first peduncular joint is large, broad, the two following joints narrow; the flagellum is composed of nine

joints and reachs a little beyond the middle of the fourth peduncular joint of the second pair of antennæ.

The second pair of antennæ have the first three joints short, the third joint being provided with an exopod, the fourth and fifth joints long and of equal length; the flagellum is multi articulate.

The first thoracic segment has the lateral margins straight, the anterior angles acutely produced forwards The lateral margins of the second, third and fourth segment are also straight, with the epimera evident about the middle.

The fifth and sixth segments have the posterior half of the lateral margin rounded, the epimera evident below. The seventh segment has the lateral margin acutely produced posteriorly, the epimera evident on the posterior margin of the segment within the processes. The thoracic segments are all widely separated from each other by deep lateral incisions

The terminal segment of the body has the lateral margin produced backwards in two small spines, between which the posterior margin is widely rounded. The uropoda are double branched, the branches being nearly equal in length and about as long as the basal joint.

The first pair of legs are subchelate. In the male the carpus is postero-distally produced in a markedly long process, which extends half the length of the propodus, its entire margin being fringed with long hairs. The propodus is elongate, its lower two-thirds being fringed with long hairs on the posterior margin, the upper third or distal margin being provided with three large spines, the inner one being bifurcate; the dactylus is long and also fringed with hairs upon its inner margin, and extends half its length beyond the last digital spine, almost touching the carpal process. The ischium is antero-distally produced in a short process.

The other legs are simple, biunguiculate.

In the female the carpus of the first pair of legs is not produced in as long a process as in the male. The propodus is shorter than in the male, more triangular in shape, denticulate on its distal margin, with a long, acute, digital spine. The dactylus does not extend beyond the digital spine. The ischium is antero-distally produced in a process fringed with hairs.

A number of individuals were taken by A. E. Verrill and party at Bailey Bay, Bermudas, in corallines, at low water, and at Harrington Sound, in 1898. Other specimens were collected at the Bermudas in 1876–7 by G. B. Goode.

Type specimens from Harrington Sound in Peabody Museum, Yale University. Cat. No. 3209.

Janira minuta Richardson, sp. nov.

PLATE XXXIX. FIGURES 50–52

Surface of body smooth. Color light yellow, almost white, spotted with black.

Head with frontal margin straight; eyes large, conspicuous, oblong, and situated at the lateral margin. First pair of antennæ with the three peduncular joints equal in length, the first one, however, being very much the broadest, the second a little stouter than the third; flagellum multi-articulate, composed of about ten or eleven joints. The second pair of antennæ have a scale outside the third joint of the peduncle; flagellum multi-articulate, much longer than the body. Thoracic segments subequal in length. First segment with the lateral margin entire, epimeron not evident from a dorsal view. Second and third segments with margins entire, straight, epimera evident about the middle of the segments. Fourth segment with the posterior half of the lateral margin slightly excavate, the epimeron evident in the excavation. The last three segments with the lateral margins entire, the epimera evident as small lobes at the post-lateral angles.

The terminal segment is about as broad as long, rounded posteriorly with a median lobe between the peduncular joints of the uropoda. The uropoda extend much beyond the terminal segment, being longer than that segment. The outer branch is somewhat shorter than the inner branch; both branches are longer than the peduncle, and are fringed with long hairs.

In the female the first pair of legs are prehensile; the others are simple walking legs, with biunguiculate dactyli. In the male, however, the first pair of legs are modified, though prehensile. The carpal joint is very much enlarged and is produced on the inside, at its outer distal end, in a long, acute process, between which and the articulation of the propodus are two long acute processes about half as long as the outer process. The propodus is similar to that of the female; the dactylus is biunguiculate.

A number of specimens, both males and females, were collected by A. E. Verrill and party in 1898, at Castle Harbor, Bermudas.

Type specimens in Peabody Museum, Yale University. Cat. Nos. 3194 and 3261.

Jæropsis rathbunæ Richardson, sp nov

PLATE XL FIGURES 53, 54, 55*a*, 55*b*, 55*c*

Body elongate, depressed, segments loosely articulated; surface smooth; color uniformly light, almost white.

Head with a median excavation, on either side of which the frontal margin is produced into angulations. On either side of these angulations is another excavation, on the outside of which are lateral angulations. A rounded lobe is placed in the median excavation. The eyes are small and are situated near the lateral margins about half way between the anterior and posterior margins. The first pair of antennæ consist of five joints, the two first joints being large, the three following ones small, the last fringed with hairs. The second pair of antennæ have a rudimentary flagellum, consisting of five or six joints; the peduncle has the third and fifth joints long and oval in shape, the fourth joint somewhat triangular.

The thoracic segments are loosely articulated. The lateral margins are straight, with no indication of epimera.

The terminal segment of the body is rounded in outline, the posterior margin excavated at the insertion of the uropoda, which do not extend beyond the edge of the segment, thus preserving the oval outline. Between the uropoda there is an acute median projection.

The legs are all simple, with biunguiculate dactyli.

One specimen was collected by A. E. Verrill and party at the Bermudas, and another by G. B. Goode, from the same locality.

Type specimens in Peabody Museum, Yale University. Cat. No. 3251.

Six species of this genus have been heretofore described: *Jæropsis lobata* Kœhler, *Jæropsis marionis* Beddard, *Jæropsis neo-zealandica* Chilton, *Jæropsis lobata* Richardson, *Jæropsis Dollfusi* Norman, and *Jæropsis curvicornis* (Nicolet).* The present species adds another to the above list. It is named in honor of Miss Mary J. Rathbun.

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* *Jæra curvicornis* Nicolet, in Gay's Hist. de Chile, iii, p. 268, Zoöl. Atlas, Crust., No. 8, fig. 10, 1849. This species should be referred to the genus *Jæropsis*.

EPICARIDEA or BOPYROIDEA.

Family **Bopyridæ**.

Bopyroides latreuticola Gissler.

Bopyroides latreuticola Gissler, Am. Nat., xvi, pp. 591–594, 1882.
Bopyrus, sp. ?, Spence Bate, Report of the Scientific Results of the Exploring Voyage of H. M. S. Challenger, xxiv, p. 582, 1888.
Bopyroides latreuticola Richardson, Proc U. S. Nat. Museum, 1901, p. 579.

Hab. Bermudas, parasitic on *Latreutes ensiferus* (Milne-Edwards), (Spence Bate); Beaufort, North Carolina, parasitic on *Latreutes ensiferus* (Milne-Edwards).

A *Bopyrid* parasitic on *Clibanarius tricolor* was collected by G. Brown Goode at the Bermudas in 1876-7.

2.—*The Terrestrial Isopoda of the Bermudas, with a Description of a New Genus of Armadillidiidæ.*

Dollfus, in his report on the terrestrial isopoda of the Challenger Expedition,* recorded from the Bermudas a number of well-known forms common to other localities. In his list were included *Tylos niveus* Budde-Lund, *Porcellio lævis* Latreille, *Metoponorthus sexfasciatus* Budde-Lund, *Armadillidium vulgare* (Latreille), and *Ligia exotica* Roux.

In addition to these forms, the collection made by Prof. A. E. Verrill and parties at the Bermudas, in 1898 and 1901, also contains the following described forms common to other localities: *Tylos Latreilli* Audouin and Savigny, *Metoponorthus pruinosus* (Brandt), and *Actoniscus ellipticus* Harger.

Only three new species, one of which is also the type of a new genus, are described herein.

*Bull. Soc. d'Études Scientifiques de Paris, xii, p. 1–8, 1890.

ONISCOIDEA.

Family Tylidae.

Tylos Latreilli Audouin and Savigny.

PLATE XL. FIGURE 56.

Tylos armadillo Latreille, Cuvier Règne animal, ed 2, iv, p. 142, 1829. Guerin, Iconogr. Crust., p. 35, pl. xxxvi, fig. 4.
Tylos Latreilli Audouin and Savigny, Descript. de l'Égypte. p. 285–87, pl. xiii, fig. 1, 1827. Milne-Edwards, Hist. Crust., iii, p. 188, 1840; Regne anim. Crust., pl. lxx, bis., f. 2. Lucas, Expl. d'Alg., i, p. 73, 1849. Heller, Verh. zoöl.-bot. Ver., Wien, xvi, p. 732, 1866. Miers, Proc Zool. Soc. Lond., p. 674, 1877. Budde-Lund, Crust Isop. Terrestria, p. 273, 274, 1885. (See Budde-Lund for synonymy.)
Tylos armadillo Dollfus,* Mém. Soc. Zool. de France, p. 550, 1896

Body elliptical in outline, very convex, and able to be contracted into a ball. Surface smooth or minutely granular and setigerous. Color yellow or light brown, marked with black spots.

Head with front not marginate; lateral angulations produced into lobes, which are truncate. Epistome forming a triangular shield, advancing some distance beyond the surface of the head. Eyes situated post-laterally. External antennæ, with a five-jointed peduncle and a flagellum consisting of four joints, extends to the posterior margin of the second thoracic segment.

The seven thoracic segments are subequal. The epimera of the first segment are represented by a thickening of the lateral edge, which is incised or cleft posteriorly. The epimera of all the other segments are dorsally separated by distinct suture lines.

The first two abdominal segments have their lateral margins covered by the seventh thoracic segment. The three following segments complete the elliptical outline of the body, their lateral margins forming a line curving inwards towards the terminal segment. The last abdominal segment is quadrangular in outline, its post-lateral angles rounded, and extends a little distance beyond the epimera of the preceding segment. The uropoda are transformed into opercular valves. At the posterior end of each large lamellar valve is a small setose joint. The third, fourth and fifth abdominal segments have

* In the Bull. Soc. d'Études Scientifiques de Paris, xiith year, pl. i, fig. 4, 1890. Dollfus gives figures of *Tylos niveus* Budde-Lund and *Tylos Latreilli* Audouin and Savigny.

plates on the ventral side extending from the margin inwards in the form of lamellæ, those of the fifth segment being longest and largest, but not meeting in the median line, being a little distance apart.

The legs are simple, ambulatory.

Three specimens were collected by Mr. J. M. Jones at the Bermudas, and about twenty more by Prof. A. E. Verrill and party at the same locality in 1898. Others were collected in 1901 at Long Bird Is., Bermudas.

Tylos niveus Budde-Lund.

Tylos niveus Budde-Lund, Crust Isop. Terr., p. 278, 1885. Dollfus, Bull. Soc. d'Études Scientifiques de Paris, xiith year, p. 8, pl. i, fig. 4*a*, 1890.

Hab. Bermudas (Dollfus). Also Key West (Budde-Lund).

Family **Oniscidæ.**

Porcellio lævis Latr

Porcellio lævis Latreille, Hist. Nat. des Crust. and Insectes, vii, p. 46, 1804.

Porcellio degeerii Audouin and Savigny, Descript. de l'Égypte, p. 289, pl. xiii, fig. 5.

Porcellio eucercus Brandt, Bull. Soc. Imp. d. Moscou, vi, p 177, 1833.

Porcellio syriacus Brandt, Bull. Soc. Imp. d. Moscou, vi, p 178, 1833.

Porcellio musculus Brandt, Bull. Soc. Imp. d. Moscou, vi, 1833.

Porcellio cinerascens Brandt, Bull. Soc. Imp. d. Moscou, vi, p. 178, 1833.

Porcellio dubius Brandt, Bull. Soc. Imp. d. Moscou, vi, p. 178, 1833.

Porcellio poeyi Guérin, Comptes Rendus, p. 182, 1837.

Porcellio urbicus Koch, Deutsch. Crust., p. 36.

Porcellio flavipes Koch, Berichtig, etc., p. 206, pl. 8, fig. 97.

Porcellio cubensis Saussure, Mém. Soc. phys., Genève, xiv, p. 477, pl. v, fig. 35, 1858.

Porcellio sumichrasti Saussure, Mém. Soc. phys., Genève, xiv, p. 478, pl. v, fig. 36, 1858.

Porcellio cotillæ Saussure, Mém. Soc. phys., Genève, xiv, p. 478, pl. v, fig. 37, 1858.

Porcellio aztecus Saussure, Mém. Soc. phys., Genève, xiv, p. 479, pl. v, fig. 38, 1858.

Porcellio mexicanus Saussure, Mém. Soc. phys., Genève, xiv, p. 479, pl. v, fig. 39, 40, 1858.

Porcellio lævis Budde-Lund, Crust. Isop. Terrestria, p. 138–141, 1885. (See Budde-Lund for synonymy and full reference.)

Porcellio lævis Dollfus, Bull Soc. d'Études Scient. de Paris, xiith year, p. 4, 1890.

Habitat, Bermudas, collected by George Brown Goode. Bermudas (Dollfus). Distribution world-wide.

Porcellio parvicornis Richardson, sp. nov.

PLATE XL FIGURE 57.

Body ovate, surface marked with minute granulations. Color yellow, with markings of light brown.

Head with median lobe small, widely rounded. Lateral lobes small, rounded. Eyes distinct, and situated on lateral lobes of head. Exterior antennæ short, about one-third the length of the body: flagellum two-jointed, first joint very much shorter than second joint, about one third shorter.

Thoracic segments subequal, with the exception of the first, which is a little longer than any of the others.

First two abdominal segments with lateral parts hidden by the preceding thoracic segment. Three following segments with lateral parts expanded, the margins continuing the oval outlines of the body. Terminal segment triangular, with sides somewhat incurved and rounded at the apex. Basal joint of uropoda reaching a little more than half the length of the last abdominal segment. Inner branch extends a short distance beyond the terminal segment of the body; outer branch extends but very little beyond inner branch.

One specimen was collected by A. E. Verrill at the Bermudas in 1901.

Type specimen in Peabody Museum, Yale University. Cat. No. 3353.

Metoponorthus sexfasciatus Budde-Lund.

Metoponorthus sexfasciatus Budde-Lund, Crust. Isop. Terrestria, pp. 167–168, 1885. Dollfus, Bull. Soc. d'Études Scientifiques de Paris, xiith year, p. 4, 1890.

Hab. Bermudas (Dollfus). Also Mediterranean and Canaries, Madeira, Azores, Spain, France, Algeria.

Metoponorthus pruinosus (Brandt).

Porcellio pruinosus Brandt, Consp. Monogr. Crust. Isop. terrestr., p. 19, fig. 21. 1833.

Porcellio maculicornis Koch, Deutschlands Crustacéen, p. 34, 1840. Stüxberg, Ofversigt af Vetensk. Akad. Forhandl., No. 2, p. 55, 1875.

Metoponorthus pruinosus Budde-Lund, Crust. Isop. Terrestria, pp. 169, 170, 1885. Sars, Crust of Norway, ii, pts. ix–x, p. 184, pl. lxxx, fig. 2, pts. xi, xii, p. 185, 1898. (See Budde-Lund for synonymy and full reference.)

Habitat, Bermudas at Harrington Sound, collected by Prof. Rankin, of Princeton; and at Walsingham, Castle Island, and Tucker's

Island Cave, collected by A. E. Verrill, 1901. Also Europe, North America, South America, North Africa, Sumatra, Madagascar.

Leptotrichus granulatus Richardson, sp nov

PLATE XL. FIGURE 58.

Body roughly and minutely granulated. Color light reddish or yellowish brown, with markings of dark brown in patches on each segment, forming four longitudinal rows, the two median rows not extending anteriorly beyond the third segment of the thorax in one specimen, and in the other being almost obsolete.

The head is produced in front in a prominent rounded median lobe, and at the sides in large rounded lateral lobes. The eyes are small, but distinct, and are placed at the base of the lateral lobes. The external antennæ are very short, not reaching the anterior angle of the first thoracic segment. The fourth joint of the peduncle is not longer than the third ; the flagellum is composed of two joints, the first of which is about half the length of the second.

The thoracic segments are subequal in length, the lateral parts broadly expanded.

The first two abdominal segments have the lateral parts undeveloped. The third, fourth and fifth segments are broadly expanded laterally, the outer margins forming a continuous and unbroken line with the margins of the thoracic segments. The terminal segment of the abdomen extends but a distance of half its length beyond the epimera of the preceding segment ; its surface is smooth. The basal joint of the uropoda attains half the length of the terminal segment. The inner branch reaches the apex of the last segment. The outer branch extends half its length beyond this.

Two specimens were collected by A. E. Verrill and party at the Bermudas in 1898. They were found in dead coral at Castle Harbor.

Type in Peabody Museum, Yale University. Cat. No. 3333.

This species cannot be identified with any of the described species of the genus: *L. panzerii* (Audouin and Savigny), *L. tauricus* Budde-Lund, *L. squamatus* Budde-Lund, and *L.** *lentus* (Budde-Lund), although it seems more closely related to the last named than to any of the former.

* See Dollfus, Mém. Soc. Zoöl. de France, pp. 542–548, 1896.

Family **Armadillididæ.**

Armadillidium vulgare (Latreille).

Armadillo vulgaris Latreille, Hist. Crust., vii, p. 48, 1804; Gen. Crust., i, p. 71, 1806. Leach, Edinb. Encycl., vii, p. 406. Lamarck, Hist. Nat. an. s. vert., v, p. 152, 1818.

Armadillo pilularis Say, Crust. United States, Journ. Acad. Nat. Sci., Philad., p. 432, 1818.

Armadillidium vulgare Budde-Lund, Crust. Isopoda Terrestria, pp. 66-68, 1885. Dollfus, Bull. Soc. d'Études Scient. de Paris, xiith year, p. 4, 1890. Sars, Crust. of Norway, ii, pts. ix–x, pl. 80, pts. xi–xii, p. 189–190, 1898.

Hab Bermudas, collected by G. B. Goode in 1876–7; and by A. E. Verrill, in 1901, at Tucker's Island; Bermudas (Dollfus). Common in all parts of Europe and neighboring regions of Asia and Africa; North America.

Uropodias Richardson, gen. nov.

Head with the front produced in a prominent rounded lobe. Eyes small, obscure. External antennæ, with a flagellum of two joints, the second joint the smaller of the two.

First six thoracic segments with the lateral parts lamellarly expanded. Seventh segment as long as the six preceding segments, but with the lateral parts undeveloped, and not wider than the first two abdominal segments, which likewise have the lateral parts or epimeral plates undeveloped. Abdomen not narrower than thorax, the lateral parts of the third, fourth and fifth segments being expanded and continuing the regular outline of the body. The abdominal segments equal in length and half as long as the thoracic segments. Terminal segment quadrangular in shape, the posterior margin produced in a median rounded lobe. The outer branch of the uropoda is large, broad, flattened, with rounded margins; the inner branch is smaller and narrower, and rounded posteriorly.

There are only six pairs of legs, the appendages of the last thoracic segment being wanting.

Uropodias bermudensis Richardson, sp. nov.

Plate XL. Figures 59, 60.

Body very convex, able to be contracted into a ball. Surface smooth. Color uniformly light brown.

Head large, produced in front in a prominent rounded projection. Eyes very small, obscure, and situated about the middle of the lateral margin. The external antennæ, with a flagellum of two joints, extend to the middle of the first thoracic segment, and are geniculate at the articulation of the third and fourth joints.

The thoracic segments are subequal in length. The seventh segment is abruptly narrower than the preceding six, and not wider than the first two abdominal segments. The seventh thoracic and the first and second abdominal segments have the lateral parts or epimeral plates undeveloped. The first six thoracic and the third, fourth and fifth abdominal segments have the lateral parts lamellarly expanded, so that the regular outline of the body is preserved, the third abdominal segment not being narrower than the six thoracic, whose lateral portions extend down laterally beyond the seventh thoracic and the first and second abdominal.

The terminal abdominal segment is quadrangular, with the posterior margin produced in a median rounded lobe. The uropoda extend but a short distance beyond the epimeral plates of the fifth abdominal segment. The outer branch is broad, flattened and round; the inner branch is smaller and narrower, and posteriorly rounded.

There are but six pairs of legs, those of the seventh thoracic segment being wanting.

A few specimens were collected by A. E. Verrill and party at the Bermudas in 1898, and at Castle Island in 1901, under stones, in dry places.

Type in the Peabody Museum, Yale University. Cat. No. 3224.

Family Trichoniscidæ.

Actoniscus ellipticus Harger.

Actoniscus ellipticus Harger, Am. Jour. Sci. (3), xv, p 373, 1878; Proc. U. S. Nat. Mus., ii, p. 157, 1879; Report U. S Fish Comm., pt vi, p. 309, pl 1, fig. 3, 1880.

Hab. Bermudas, collected by G. B. Goode, 1876–7 (one specimen of a brown and yellow mottled color); and near Hungry Bay, Bermudas, near salt water under decayed sea-weed and stones, collected by A. E. Verrill in 1901. Savin Rock, near New Haven; Stony Creek, Long Island Sound.

Family **Ligiidæ.**

Ligia baudiniana Milne-Edwards.

Ligia baudiniana Milne-Edwards, Hist. des Crust., iii, pp. 155-156, 1840.
? *Ligia baudiana* Spence Bate, Ann Mag. Nat Hist. (4), i, pp. 443, 446, 1868.
? *Ligia baudiniana* Saussure, Mém Soc. phys. Genève, xiv, p. 476, 1858.
Ligia exotica Dollfus, Bull Soc. d'Études Scientifiques de Paris, xiith year, p. 7, 1890.
Ligia exotica hirtitarsis Dollfus, Bull. Soc. d'Études Scientifiques de Paris, xiith year, p. 7, 1890.
Ligia baudiana Ives, Proc Acad. Nat. Sci. Phila., pp 185, 186, pl. vi, fig. 2, 1891.
Ligia baudiniana Richardson, Proc United States Nat. Museum, xxiii, p. 574, 575, 1901.
Ligia gracilis Moore, Report U. S. Fish Comm., ii, pp. 161-176, pl. 7-11, 1901

PLATE XL. FIGURE 61.

Hab. Bermudas, collected by George Brown Goode in 1876–77, and by A. E. Verrill and party in 1898 and 1901; Bermudas, collected by J. M. Jones; Bermudas (Dollfus); San Juan d'Ulloa, Mexico (Milne-Edwards); Yucatan (Ives); Rio Janeiro (Spence Bate); Cuba (Saussure.)

"At the Bermudas the *Ligia* occurs in great abundance on the ledges and cliffs along all the shores. It runs with surprising activity and quickly seeks refuge in the cracks and crevices of the ledges, so that it is not easy to capture without injury.

Its dark, bluish-gray color is not particularly protective here, unless in the night, owing to the light color of most of the rocks, but on darker rocks it would be decidedly protective." A. E. V.

It is doubtful if the specimens found at Cayenne by Miers* and identified by him as *Ligia baudiniana* really were that species. I am inclined to think they should be referred to *Ligia exotica.* In his description of them, Miers states that the antennæ are very long, reaching in one specimen to the extremity of the body, and in the other specimen not quite, but almost to the extremity. The first was probably the male and the other the female of *L. exotica.* There has been much difference of opinion in regard to these two species, *Ligia baudiniana* and *Ligia exotica*, the former being considered by Budde-Lund† and Dollfus‡ as a synonym of the latter, although Dollfus states of the specimens found at the Bermudas, and

* Proc. Zoöl. Soc. Lond., p. 670, 1877.
† Crust. Isop. Terrestria, p. 267, 1885.
‡ Bull. Soc. d'Études Scientifiques de Paris, xiith year, p. 7, 1890.

which he identified as *L. exotica*, that they differed from the specimens of *L. exotica* in his collection from Senegal in the thickness of the tarsus, which was furnished with long, stiff hairs in the males. However, he did not consider this a specific character; it could only be sufficient to distinguish a variety, for which he proposed the name *hirtitarsis*. His specimens should undoubtedly be referred to *Ligia baudiniana*, the characters of which, as a distinct species, near, perhaps, but not identical with *Ligia exotica*, I shall endeavor to point out.

A comparison of male specimens of *Ligia baudiniana* and *Ligia exotica* show the following points of difference:

First, in the size and formation of the body, *Ligia baudiniana* being the smaller species, with the body more compact than in *L. exotica*, which has the segments very loosely articulated.

Second, in the length of the antennæ, which in *L. baudiniana* do not extend beyond the last segment of the thorax (which character is constant, being true of all the specimens examined), while in *L. exotica* the antennæ reach the extremity of the body in all the specimens examined.

Third, in the length of the peduncle of the antennæ, which in *L. baudiniana* extend to the posterior margin of the second thoracic segment, the last two joints being shorter than in *L. exotica*, the peduncle of whose antennæ reach the posterior margin of the third thoracic segment.

Fourth, in the character of the first pair of legs in the two species, those of *L. exotica* (plate xl, figs. 62*a*, 62*b*,) having the propodus furnished near the apex with a conspicuous process, oval and produced, the carpus and merus not being fringed with a thick row of long stiff hairs, while those of *L. baudiniana* (fig. 61) have the propodus simple, unarmed aud without a conspicuous process, the carpus and merus being fringed along the entire posterior margin with a row of long stiff hairs.

Fifth in the shape of the terminal segment of the body, the angle in the middle of the posterior margin being more acutely produced in *L. exotica* than in *L. baudiniana*, and the lateral angulations being also much more produced. In the color of the two forms, *L. baudiniana* being much lighter in color, the color extending to the margins of the segments, while in *L. exotica* there is a colorless border on the lateral and posterior edges of all the segments.

In the females of the two species the first pair of legs are simple. The antennæ are shorter than in the males, and the peduncle of the

antennæ is also shorter In the female of *L. exotica* the antennæ do not quite reach the extremity of the body; in the female of *L. baudiniana* they do not quite reach the extremity of the thorax. In the female of *L. exotica* the peduncle of the antennæ extends only to the posterior margin of the second thoracic segment; in the female of *L. baudiniana* the peduncle of the antennæ does not extend beyond the posterior margin of the first thoracic segment.

The species recently described by Mr Moore* as *Ligia gracilis*, found at Porto Rico, is identical with *Ligia baudiniana.* The type specimens of *Ligia gracilis*, which have been placed in the U. S. Nat. Museum, have been carefully examined by Mr. Moore and myself since the publication of his paper, and exhibit the same characters found in *Ligia baudiniana.* The leg of the first pair, figured by Mr. Moore, is the leg of the female, which does not present the row of stiff hairs on the carpus and merus, as found in the male.

Although Mr. Moore did not investigate the differences existing between *L. exotica* and *L. baudiniana*, and was misled by such eminent authorities as Dollfus and Budde-Lund,† who consider the latter species a synonym of the former, yet he regarded his specimens, when compared with specimens of *L. exotica*, as specifically distinct. Although *Ligia gracilis* cannot be considered new, yet the fact that Mr. Moore considered his specimens specifically different from *L. exotica*, and his identification of them later with *L. baudiniana* give additional weight to the view that *Ligia baudiniana* is distinct from *Ligia exotica.*

* Report U S Fish Commission, ii, pp. 161–176, pl. 7–11, 1901.

† It is very doubtful if Budde-Lund ever had specimens of *L. baudiniana.* He places *L. baudiniana* in the synonymy of *L. exotica*, with a question mark

EXPLANATION OF PLATES.

Plate XXXVII.

Figure 1.—*Apseudes triangulata* R., sp. nov. Head. × 35.
Figure 2.—The same. Segments of thorax and abdomen. × 19$\frac{4}{5}$.
Figure 3.—The same. Segments of abdomen and part of uropods. × 35.
Figure 4.—The same. First gnathopod. × 35.
Figure 5.—The same. Second gnathopod. × 35.
Figure 6.—*Apseudes propinquus* R., sp. nov. Head. × 35.
Figure 7.—The same. Segments of thorax and abdomen. 19$\frac{4}{5}$.
Figure 8.—The same. Last four segments and part of uropods. × 35.
Figure 9.—The same. First gnathopod. × 35.
Figure 10.—*Parapseudes goodei* R., sp. nov. Head and first thoracic segment × 35.
Figure 11.—The same. General figure × 19$\frac{4}{5}$.
Figure 12.—The same. Abdomen with uropods and last thoracic segment. × 35
Figure 13.—The same. First gnathopod of female. × 35.
Figure 14.—The same. First gnathopod of male. × 35.

Plate XXXVIII.

Figures 15*a*, 15*b*.—*Paranthura infundibulata* R., sp. nov. Mandible and maxillipeds. × 33.
Figure 16*a*.—The same. Antenna of first pair. × 33.
Figure 16*b*.—The same. Antenna of second pair. × 33.
Figure 17.—The same. Last four thoracic segments and abdomen. × 11$\frac{5}{8}$.
Figure 18.—The same. Lateral view of abdomen. × 11$\frac{5}{8}$.
Figure 19.—The same. First gnathopod. × 32$\frac{1}{2}$.
Figure 20.—The same. Second gnathopod. × 32$\frac{1}{2}$.
Figure 21*a*.—*Paranthura verrillii* R., sp. nov. Antenna of first pair. × 32$\frac{1}{2}$.
Figure 21*b*.—The same. Antenna of second pair. × 32$\frac{1}{2}$.
Figure 22.—The same. Last two thoracic segments and abdomen. × 11$\frac{5}{8}$.
Figure 23.—*Colanthura tenuis* R., sp. nov. Head and antennæ. × 62.
Figure 24.—The same. General figure. × 18$\frac{5}{8}$.
Figure 25.—The same. Abdomen and last two thoracic segments. × 62.
Figure 26.—The same. Lateral view of uropoda. × 62.
Figure 27.—The same. First pair of legs. × 62.
Figure 28.—The same. Second pair of legs. × 62.
Figure 29.—*Anthelura affinis* R., sp. nov. General figure. × 32$\frac{1}{2}$.
Figure 30.—The same. First gnathopod. × 62.
Figure 31.—The same. Second gnathopod. × 62.
Figure 32.—The same. Sixth periopod. × 62.
Figure 33.—*Colopisthus parvus* R., sp. nov. General figure. 11$\frac{5}{8}$.
Figure 34.—The same. Head and first two thoracic segments. × 18$\frac{5}{8}$.
Figure 35.—The same. First maxilla. 32$\frac{1}{2}$.
Figure 36.—The same. Second maxilla. 32$\frac{1}{2}$.
Figure 37.—The same. Maxilliped. × 32$\frac{1}{2}$.
Figure 38*a*.—*Alcirona krebsii* Hansen. First maxilla. × 32$\frac{1}{2}$.
Figure 38*b*.—The same. Maxilliped. × 32$\frac{1}{2}$.

PLATE XXXIX.

Figure 39.—*Dynamene perforata* Moore. Last two thoracic segments and abdomen. × 17¼.

Figure 40.—*Sphæroma crenulatum* R., sp. nov General figure. × 17¼.

Figure 41.—See plate xl.

Figure 42.—*Carpias bermudensis* R., sp. nov. Mandible × 58.

Figure 42*a*.—The samo. Maxilliped. × 58.

Figure 42*b*.—The same First maxilla. × 58.

Figure 42*c*.—The same. Second maxilla. × 58.

Figure 43.—The same. Male operculum. × 58.

Figure 44.—The same. Female operculum. × 58.

Figure 45.—The same. First leg of male. × 80¾

Figure 46.—*Stenetrium stebbingi* R., sp. nov. Head and first thoracic segments. × 80¾.

Figure 47.—The same Terminal segment of body and uropoda × 80¾

Figure 48.—The same. First leg of male. × 80¾.

Figure 49.—The same. First leg of female. × 80¾.

Figure 50.—*Janira minuta* R., sp. nov. Terminal segment and uropoda. × 58.

Figure 51.—The same. Leg of first pair of female. × 58.

Figure 52.—The same. Leg of first pair of male. × 58.

PLATE XL

Figure 41.—*Carpias bermudensis* R., sp. nov General figure. × 18⅔.

Figure 53.—*Jæropsis rathbunæ* R., sp. nov. Head and first thoracic segment. × 32¼.

Figure 54 —The same. Terminal segment and uropoda. × 32¼.

Figure 55*a*.—The same. Mandible. 32¼.

Figure 55*b*.—The same Mandible. 32¼.

Figure 55*c*.—The same. Maxilliped. 32¼.

Figure 56.—*Tylos armadillo* Latreille. Operculum.

Figure 57.—*Porcellio parvicornis* R., sp. nov. General figure.

Figure 58.—*Leptotrichus granulatus* R., sp. nov. General figure. × 11⅔.

Figure 59.—*Uropodias bermudensis* R., sp. nov. Head and first thoracic segment. × 62.

Figure 60.—The same. Abdominal segments and last two thoracic segments. × 62.

Figure 61.—*Ligia baudiniana* Milne-Edwards. First leg of male. × 11⅔.

Figure 62*a*.—*Ligia exotica* Dollfus. First leg. × 11⅔.

Figure 62*b*.—The same. Terminal joints. × 11⅔.

VIII.—The Reconstruction of a Cretaceous Dinosaur, Claosaurus annectens Marsh. By Charles E. Beecher. (With Plates XLI to XLV.)

Introduction.—The completion of the mounting of the skeleton of a large dinosaur is a matter of considerable moment to any museum, as well as of some general scientific interest. Although the subject lies wholly outside the particular field of research of the writer, it still seems desirable to present, even imperfectly, some description of a specimen which is in many ways unique, and by chance is the first dinosaurian skeleton to be mounted in America.

In most kinds of construction the concrete result is usually found to differ in many particulars from the ideal or mental picture as expressed in language or by an artist. This being a general statement of fact, one would naturally expect some discrepancy between the pictured restoration of the skeleton of an extinct animal and the skeleton itself when actually put together and mounted.

The limitations of paleontologic work require that in order to give a general conception of an animal, this must be represented by a drawing or model in which the missing parts are restored according to the best knowledge and inference on the part of the investigator. The more complete the material studied, the more satisfactory and accurate the restoration is likely to become. An illustration of this fact will appear later on.

Even when approximately entire skeletons of fossil vertebrates are discovered, the bones are usually found displaced, and their nature and position are determined principally by comparative studies on other better known animals supposed to be related or to have analogous features. In the study of a group of vertebrate animals that is wholly extinct and has left no direct descendants, the difficulties of attempting to make a restoration of any particular type are considerably increased. This applies either to a drawing or to the mounting of the skeleton in a manner which shall be rendered true to nature, by placing all the bones in their proper position and giving the skeleton a posture it may have had during life. It has therefore come about that *the positive information conveyed by the finding of a foot or of any other portion of a skeleton, with the bones in a sequential position in the rock, is of far greater anatomical value than any number of expert opinions.*

In 1891, the Yale University Museum received the skeleton of a herbivorous dinosaur from the Laramie beds of the Cretaceous in Converse County, Wyoming. The specimen is one of the many treasures in the Marsh collection, and was obtained in the field by Mr. J. B. Hatcher and party. This skeleton and another apparently belonging to the same species were made the basis of the pictorial restoration of *Claosaurus annectens*, as published by the late Professor Marsh.* On account of the completeness of the material, and especially because many of the more important bones were in their true position in the rock, the writer decided to direct the preparation of the specimen as a museum exhibit. Most of the work of mounting has been performed in an admirable manner by Mr. Hugh Gibb, preparator in the Geological Department, and to his skill is due the elegance of the finish and the solid strength of the specimen.

The animal lay on its side in the rock and was somewhat laterally compressed. The preservation was such that the left side was in much better condition than the right. It was therefore decided to mount the skeleton in high relief on a slab consisting in part of the original sandstone matrix. The amount of relief shows all four limbs, those on the left side being entirely free. The left side of the entire vertebral column is exposed and the head shows the front, back, top, bottom, and left side, the right only being concealed.

Owing to the shattered condition of the left femur (making it impracticable to free it from the matrix) and to its being in the rock in its true position with respect to the pelvis, the pose of the animal was determined in large measure by this bone. It is directed forward at such an angle as to demand a running position for bipedal locomotion. An attempt has been made to carry out this idea of rapid motion and to make all parts of the skeleton contribute to the completeness and realism of the general effect. In order to do this there must be the proper balance and the true swing of the living animal.

It is intended, therefore, that this huge specimen, as now mounted, should convey to the observer the impression of the rapid rush of a Mesozoic brute. The head is thrown up and turned outward. The jaws are slightly separated. The fore arms are balancing the sway of the shoulders. The left hind leg is at the end of the forward stride and bears the entire weight of the animal. The right foot has completed a step and has just left the ground preparatory to the forward swing. The ponderous and powerful tail is lifted free and doubly curved so as to balance the weight and compensate for the

swaying of the body and legs. The whole expression is one of action and the spectator with little effort may endow this creature with many of its living attributes.

In seeking to secure a life-like pose for *Claosaurus*, considerable assistance was afforded by photographs of existing animals in motion, especially several illustrating bipedal locomotion among living lizards. One of these is here introduced for comparison (figure 1).[*]

FIGURE 1.—Running lizard, illustrating bipedal locomotion. From photograph of living *Chlamydosaurus*, by W. Saville Kent.

Synonymy.—It is not within the province or purpose of this paper to enter into any analyses or discussions of generic synonymy, though the proper reference of the animal here described is somewhat uncertain. The type species of *Claosaurus* (*C. agilis* Marsh[*]) was obtained from the Niobrara of Kansas, and is possibly generically distinct from the species afterward described from the Laramie as *Claosaurus annectens*, by Professor Marsh.[†] Neither is it feasible at present to bring evidence that *Thespesius occidentalis* of Leidy[‡] does not include the Laramie type. The fragmentary remains upon which *Thespesius* was based consisted only of several vertebræ and a phalangial bone. These portions seem to have very little diagnostic value within the group. Therefore the relationships of these forms, as well as questions of priority, must be left for future careful comparisons, and for the present it seems best to accept the name *Claosaurus annectens* for this species.

Restorations of Ornithopoda.—Several restorations of various members of the Ornithopoda have been already made, including the genera *Iguanodon*, *Hadrosaurus*, *Claosaurus*, *Hypsilophodon*, *Laosaurus*, and *Camptosaurus*. The last three in the list have been restored only by means of drawings.

Hadrosaurus was modelled by Waterhouse Hawkins to represent both the skeleton and the animal in the flesh. Owing to the extremely fragmentary remains upon which this restoration was based it was necessarily very faulty and has long since ceased to have any value or interest except as a historical attempt. A figure

of it is here introduced (figure 2). With somewhat greater success

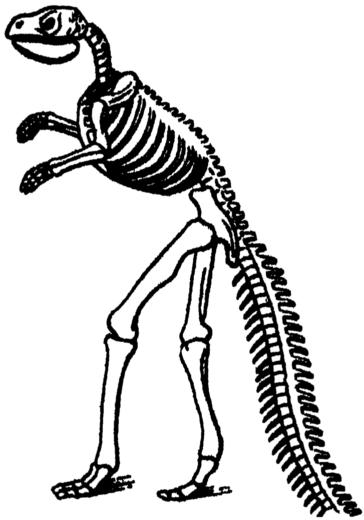

FIGURE 2.—Restoration of *Hadrosaurus* After Hawkins

Hawkins also restored the *Iguanodon*, from material in the English museums. The later discovery of a number of quite complete skeletons of this genus in Belgium, and their careful analysis by Dollo,[1] led to a subsequent successful restoration in a superb manner by De Pauw (figure 3).

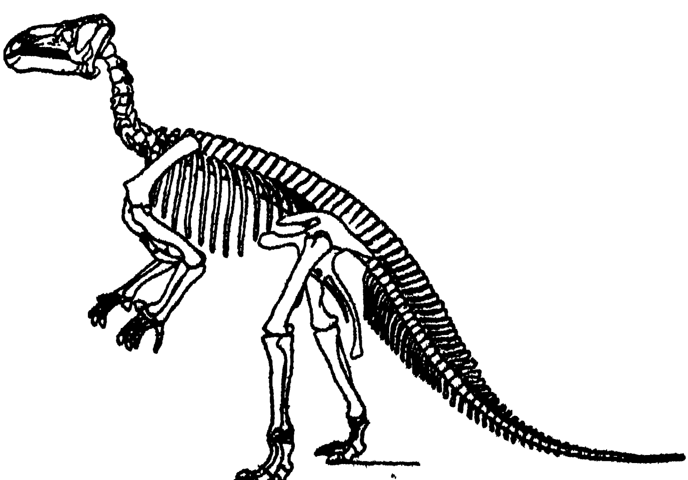

FIGURE 3.—Restoration of *Iguanodon bernissartensis*; one-eightieth natural size. After Dollo.

The Pose of Claosaurus.—The entire skeleton of *Claosaurus*, as already mentioned, was given in a drawing published by Professor Marsh. This drawing is here reproduced (figure 4), since it differs

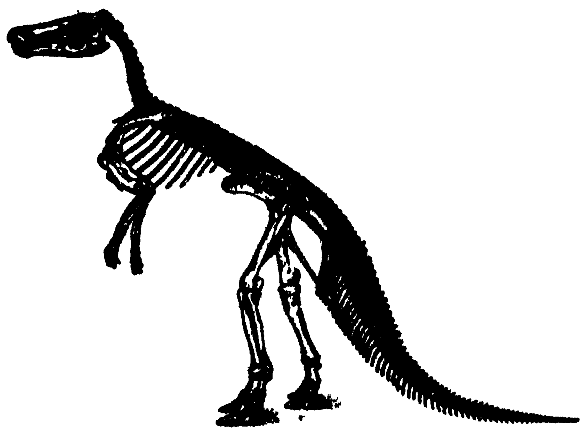

FIGURE 4.—Restoration of *Claosaurus annectens*, one-eightieth natural size After Marsh

in some important details from the skeleton now mounted (Plates XLI–XLV). It represents the animal as standing nearly on the ends of the toes, with the tail resting on the ground and with pendent fore limbs.

In the mounted specimen, for reasons previously stated, the animal was placed in a running position. Moreover, since there is an obvious analogy between the habits and posture of *Iguanodon* and *Claosaurus*, and the footprints of the former show no marks of a dragging tail, the latter was mounted with the tail raised to balance the weight of the animal. Further, this is the position assumed by modern lizards employing bipedal locomotion (figure 1). In *Claosaurus* the ischia are closely united at their distal ends, and it would have been impossible for the chevrons to pass between them as shown in figure 4. Without doubt the animal could have sat down or dropped the tail to the ground. The mounted skeleton shows that there were really four instead of two post-sacral vertebræ without chevrons, and that the first chevrons were short and very oblique so as entirely to clear the ends of the ischia (Plate XLIII).

The present restoration represents the animal as touching nearly the whole length of the toes to the ground (figure 5). This position was adopted because of the fact that all the bird-like dinosaurian footprints show the imprint of nearly the full length of the phalanges

The attitude of the fore limbs depends largely upon the placing of the scapula. In Professor Marsh's illustration the scapula is represented at about sixty degrees inclination to the vertebral column.

FIGURE 5.—*Claosaurus annectens* Marsh; left hind foot, with tibia and fibula; one-tenth natural size.

The same position was previously adopted in the mounting of *Iguanodon* (figure 3), and in both cases it results in throwing the fore limbs down so that they would lose much of their value as

organs of prehension. The present mounted specimen of *Claosaurus* shows the left scapula lying on the ribs nearly parallel to the direction of the vertebræ (Plate XLIV, figure 1). The reason for this is, primarily, that the bone is placed where it was *found* in the rock in connection with the body, and as so much of the remaining portions of the skeleton was in a normal position, it seemed safe to assume that the scapula, also, was in its true place. It is likewise of the greatest significance that, in the specimen of *Iguanodon* figured by Dupont,[2] the position of the scapula as it was lying in the rock is precisely identical and not as subsequently placed in the mounted specimen (see figures 3, 6). It is quite possible that the present

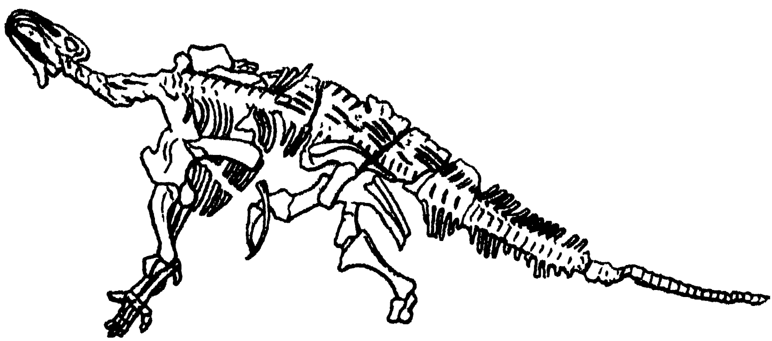

FIGURE 6.—Skeleton of *Iguanodon* in position in the rock. After Dupont

scapula belongs higher up, though still retaining its parallel position, but the actual location does not involve any question of judgment, since the bone is where found. The scapulæ in most birds (compare skeleton of Penguin) are almost parallel to the vertebral axis, and a similar position among the Ornithopoda would not be unexpected.

The structure of the pollex in *Claosaurus* shows that it was probably opposable to the other digits and functioned as a true thumb. This with the slender form of the whole manus indicates that the fore limbs were properly organs of prehension. To be thus used to the greatest advantage, the position of the scapulæ parallel with the axis would be an obvious structural benefit.

There are a number of minor anatomical differences between the actual specimen and its original pictorial representation which could be discussed, but those here mentioned are believed to be the more important ones. These discrepancies have arisen largely from the difficulty in construing the whole or parts of a skeleton before the actual articulation of the bones is attempted.

Condition of the Skeleton and Amount of Restoration. (See Plate XLV.)—The head and neck have been left in the original matrix, with the exception of the five posterior cervicals, which were separated in order to form the curve joining the trunk. As found, the head was bent under the body and the cervicals turned ninety degrees from the median plane. This accounts for the fact that the neural spines are directed outward.

The series of dorsal vertebræ is complete. The spines of the posterior dorsals are restored. With the exception of the second, the ribs from the first to the seventh were modelled from those on the right side, while those remaining on the left side are well preserved and in the matrix. They are somewhat bent by pressure, but it was thought best to leave them as originally found, especially as the impression of the blade of the scapula was preserved. The right scapula of this individual is complete, but it was necessary to restore the left one and to substitute the anterior half of the scapula of another individual. The coracoid is modelled from another specimen. The sternal bone is complete and belongs to this skeleton. Both humeri, radii, and ulnæ were preserved, as well as the metacarpals of both fore feet. The carpal bones were modelled after Professor Marsh's drawing. About half the phalangial bones were preserved, and the missing ones have been modelled.

The sacrum and pelvic region were quite complete and are still in the rock, the only restoration necessary being the spines of the sacral vertebræ and part of the posterior portion of the ilium, which were modelled from another specimen. The left pubis and ischium were essentially entire.

The outside of the left femur was considerably exfoliated and shattered and has been restored, though the main part of it is in its original position in the rock. The end of the right femur is also partially restored.

The remaining bones of both hind legs and both feet were all in proper sequence in the rock, the only missing bone being the terminal phalanx of the middle toe of the left foot. This was supplied by a cast of the same bone in the right foot.

A considerable portion of the tail was wanting, though fortunately the proximal third was nearly perfect and in a natural position, with the chevrons attached. The middle and distal portions were represented by a number of detached vertebræ, and with the information furnished by an entire tail of another specimen it has been possible to restore this member in a satisfactory manner.

The ossified tendons were mostly weathered away or very much broken and no attempt to restore them has been made. A small group is preserved over the spines of the first five caudal vertebræ.

From the foregoing somewhat detailed statement of the actual and restored portions of this skeleton it is at once evident that for a fossil vertebrate it is unusually complete. The most important parts, as the pelvic region, the hind limbs, most of the bones of the fore limbs, and the head and neck, were not only well preserved but were in their true sequence and largely in their normal position.

Method of Mounting.—The skeleton of *Claosaurus* is mounted on a slab consisting in part of the natural stone and in part of a rock surface manufactured from ground and disintegrated Laramie sandstone. The slab measures twenty-six feet ten inches, in length, by fourteen feet two inches, in height; and has a base two feet two inches wide, extending out from the lower edge, and upon which the feet rest. This method of mounting fossil skeletons has been employed with great success in the American Museum of Natural History, New York, and is especially well adapted for skeletons that are somewhat compressed or are more or less imperfect on one side. The present specimen is very much larger than anything heretofore attempted, and the result shows that slab mounts can be practically employed with success for animals of considerable size.

For convenience in handling and to provide for the future possibility of moving this specimen, it was mounted in four sections, which may be detached by simply breaking the thin artificial rock crust and removing the bolts holding them together. Each section rests upon a truck supported on strong casters. This construction is of course entirely concealed by the casing and framing of the finished mount.

The sections were made of timbers measuring three by four inches in section, with vertical and horizontal cross pieces at regular intervals. The horizontal base was attached by means of heavy double angle-irons. On these frames the pieces of rock carrying the bones, together with the separate bones, were securely fastened and the intervening spaces covered with wire netting of one-half inch mesh. Over this netting was spread a thin layer of plaster of Paris, and lastly a still thinner layer of ground Laramie sandstone mixed with plaster of Paris and gum Senegal. Before the artificial rock covering was thoroughly hardened the surface was tool-dressed, thus giving it the same appearance as the surface of the real rock where it was chiseled away to expose the bones. The left fore and

hind limbs are entirely free from the slab and are supported by irons in the usual way. They are mounted so that they can be readily detached and taken apart for purposes of study. The original rock connections of all the bones have been preserved and there can be no controversy over their primary order and sequence.

Dimensions.—The entire length of the animal measured along the spinal column is twenty-nine feet three inches (8.79^{m}), and the height of the head above the base is a little over thirteen feet (4^{m}). From the shoulder to the base is ten feet (3.08^{m}), while the hind limbs are about nine and a half feet long (2.89^{m}). The tail measures thirteen feet seven inches, in length (4.17^{m})

Measurements of the Skull

Total length	102^{cm}
Greatest vertical diameter	42^{cm}
Length in front of teeth	88^{cm}

Measurements of the Lower Jaw

Greatest length of ramus to articulation	78^{cm}
Greatest depth of ramus through dentition	16^{cm}

Measurements of Shoulder Girdle and Fore Limbs

Scapula, length	86^{cm}
Scapula, greatest width of blade	86^{cm}
Scapula, least width of blade	19^{cm}
Coracoid, length	27^{cm}
Humerus, length	59^{cm}
Humerus, diameter of distal end	18^{cm}
Humerus, least diameter	8^{cm}
Radius, length	55^{cm}
Radius, diameter of proximal end	8^{cm}
Radius, diameter of distal end	7^{cm}
Radius, least diameter	4^{cm}
Ulna, length	60^{cm}
Ulna, diameter of proximal end	12^{cm}
Ulna, diameter of distal end	10^{cm}
Ulna, least diameter	5^{cm}
Metacarpal I, length	11^{cm}
Metacarpal II, length	25.5^{cm}
Metacarpal III, length	27^{cm}
Sternal bone, length	42^{cm}
Sternal bone, width	26^{cm}

Measurements of the Pelvic Arch.

Greatest length	184cm
Diameter of acetabulum	26cm
Ilium, length	115cm
Pubis, length in front of acetabulum	60cm
Ischium, length posterior to acetabulum	115cm

Measurements of the Hind Limbs.

Whole length	289cm
Femur, length	106cm
Femur, least diameter of shaft	16cm
Tibia, length	95cm
Tibia, diameter of proximal end	29cm
Tibia, diameter of distal end	26cm
Tibia, least diameter of shaft	10cm
Fibula, length	92cm
Fibula, diameter of proximal end	14cm
Fibula, diameter of distal end	12cm
Fibula, least diameter of shaft	5cm
Metatarsal I, length	26cm
Metatarsal I, diameter of proximal end	18cm
Metatarsal I, diameter of distal end	15cm
Metatarsal II, length	36cm
Metatarsal II, diameter of proximal end	17cm
Metatarsal II, diameter of distal end	13cm
Metatarsal III, length	28cm
Metatarsal III, diameter of proximal end	18cm
Metatarsal III, diameter of distal end	9cm
Phalanx of I, length of proximal	14cm
Phalanx of I, diameter of proximal	10cm
Phalanx of I, length of median	6cm
Phalanx of I, diameter of median	7cm
Phalanx of I, length of ungual	9cm
Phalanx of I, diameter of ungual	9cm
Phalanx of II, length of proximal	12cm
Phalanx of II, diameter of proximal	10.5cm
Phalanx of II, length of second	5cm
Phalanx of II, diameter of second	11cm
Phalanx of II, length of third	4cm
Phalanx of II, diameter of third	9.5cm
Phalanx of II, length of ungual	10cm
Phalanx of II, diameter of ungual	11cm
Phalanx of III, length of proximal	12cm
Phalanx of III, diameter of proximal	9cm
Phalanx of III, length of second	3.5cm
Phalanx of III, diameter of second	8cm

Phalanx of III, length of third	8.5cm
Phalanx of III, diameter of third	7cm
Phalanx of III, length of fourth	8cm
Phalanx of III, diameter of fourth	6.5cm
Phalanx of III, length of ungual	9cm
Phalanx of III, diameter of ungual	8cm

Measurements of the Tail.

Length	417cm
Width at 8th chevron	63cm
Diameter of centrum in 3d caudal	8cm
Diameter of centrum in 30th caudal	7cm
Diameter of centrum in 45th caudal	3.5cm
Diameter of centrum in 60th caudal	3cm

Measurements of Ribs.

Length of first rib	43cm
Length of second rib	80cm
Length of third rib	100cm
Length of fourth rib	110cm
Length of fifth rib	117.5cm
Length of sixth rib	125cm
Length of seventh rib	125cm
Length of eighth rib	122.5cm
Length of ninth rib	112.5cm
Length of tenth rib	97.5cm
Length of eleventh rib	88.5cm
Length of twelfth rib	77.5cm
Length of thirteenth rib	55cm
Length of fourteenth rib	42.5cm
Length of fifteenth rib	32.5cm
Length of sixteenth rib	30cm
Length of seventeenth rib	27.5cm

The Right Scapula (Plate XLIV, figure 1).—The right scapula is well preserved and shows one very interesting feature. Near the lower edge of the blade is an elongate elliptical hole, 8cm in length, with smooth edges, indicating that the animal received a severe injury during life and completely recovered from it before death. It is, of course, idle to speculate on the character of this accident, yet the presence in the same beds of numerous remains of the armored and horned *Triceratops* suggests that there may have been an encounter between this *Claosaurus* and one of the individuals of the Ceratopsidæ. The injury to the scapula is just such a one as could be made by a thrust of one of the horns of *Triceratops*.

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EXPLANATIONS OF PLATES.

Plate XLI.

Claosaurus annectens Marsh.

Side view of mounted specimen; one-fortieth natural size.

Owing to the impossibility of properly lighting the specimen for photographic purposes, it has been necessary to paint out the background and shadows in the negative. Therefore this illustration merely gives a projection, and does not show the high relief of the specimen.

Plate XLII.

Claosaurus annectens Marsh.

Oblique side view. As in the preceding plate, it was necessary to paint out the background, with the consequent loss of actual relief.

Plate XLIII.

Claosaurus annectens Marsh.

Pelvis and hind limbs, with proximal portion of tail; one-eighteenth natural size.

This illustration shows the detail of mounting and the finish of the slab. Plates XLI and XLII should show the same characters of rock surface and the same degree of relief.

Plate XLIV.

Claosaurus annectens Marsh.

Figure 1.—Right scapula; showing elliptical perforation of blade due to an injury received during life; two-fifteenths natural size.

Figure 2.—Anterior portion of skeleton; showing the fore limbs, shoulder girdle, neck, and skull; one-nineteenth natural size.

Plate XLV.

Claosaurus annectens Marsh.

Line drawing; showing real and restored parts.

Original bones are represented by line shading.

Bones partially restored are represented by dotted line shading.

Bones wholly restored are represented in outline.

IX.—The Ascidians of the Bermuda Islands.

By Willard G. Van Name, Ph.D.

In preparing the account of the Bermuda ascidians which is presented in the following pages, the writer has hoped that it would not be of local interest only. The waters about these islands are remarkably rich in animals of this class, including many new species and several new genera, and the Tunicata of the part of the world in which the Bermuda Islands are situated are only slightly known.

The species which have been described from the Atlantic coast of North America are for the most part northern forms, from the British Provinces and the New England States. Concerning those of the Southern States but little is recorded. A large number of species of Simple Ascidians from the West Indies and the adjacent parts of tropical America have been described in the works of Heller (4, 5), Traustedt (16), and Sluiter (15), though these writers had only preserved, and often very insufficient, material as a basis for their descriptions and figures. Only one of these writers (Sluiter) describes any Compound Ascidians from this region, and he describes only a very few.

Our knowledge in regard to the Tunicata of the Bermuda Islands themselves was until very recently confined to the six species obtained there by the Challenger Expedition, and described by Herdman (6) in the reports of that voyage.

In the spring of 1898, Prof. A. E. Verrill, of Yale University, and a party of students under his direction, made a general collection of the invertebrates of the Bermuda Islands, and among them a considerable number of ascidians were obtained, though particular attention was not directed to this class of animals. But few Simple Ascidians were comprised in this collection. Most of these were described by Prof. Verrill in these Transactions (Vol. x, 1900), as well as one new Compound Ascidian. He also mentioned four genera of the latter which had not been previously recorded from there, though he did not describe or identify the species.

Prof. Verrill has turned over to the writer the entire collection of Tunicata obtained by that expedition, and this paper is in part the result of a study of those specimens. In the spring of 1901, Prof. Verrill and Mr. A. Hyatt Verrill made another trip to Bermuda and obtained an even larger collection of Tunicata than in 1898, and the

writer himself spent some time during the months of April and May of that year at Bermuda, part of the time in company with Prof. Verrill, and has consequently been able to collect and study nearly all the species in a living state and in their natural surroundings. The writer has also examined some specimens obtained by Prof. G. Brown Goode in the years 1876 and 1877, though there proved to be no forms among them which were not also obtained by the Yale parties.

The fauna of the Bermuda Islands is exceedingly rich in Compound Ascidians, not only in the number of species, but in individuals also, many of the forms being very abundant and generally distributed about the islands. There may be other localities of no greater extent where an equal variety of species and abundance of individuals may be found, but there are probably few places where all the generally recognized families of this group are so fully represented. A very large proportion of the more important genera of the Compound Ascidians are also present, and a study of the Bermuda forms comes very near to giving a complete and comprehensive idea of this group of animals.

With the Simple Ascidians the case is different. The genera and species are few, and though some of the species are common, none are conspicuously abundant. One large and important family, the Molgulidæ, does not appear to be represented at all.

No examples of the free-swimming Tunicata, the Pyrosomidæ, Thaliacea, and Larvacea were obtained, but no collecting of a kind likely to result in finding them was attempted, owing to lack of time. Unquestionably representatives of all these groups occur in the vicinity of the islands and will be found when sought for.

The following are the Bermuda Tunicata described by Herdman in the Challenger Reports :—

Symplegma viride.
Didemnum (?) inerme.
Botrylloides nigrum.
Ecteinascidia turbinata.
Clavelina oblonga.
Ascidia nigra Savigny,
(=*A. atra* Lesueur).

All but the last of these were new species. With the exception of *Symplegma viride* and perhaps *Didemnum (?) inerme* they are represented in the Yale collections.

Didemnum inerme is a form described by Herdman from a single small specimen in such a poor state of preservation that nothing could be made out in respect to the structure of the zoöids, and he is

consequently uncertain in regard to the genus and even of the family in which it should be placed. Considering the difficulty of recognizing most species of Compound Ascidians even when an abundance of well preserved material is at hand, the practice of describing new species from such wretched specimens need not be commented on. The writer does not believe that the animal in question is a *Didemnum*. It may or may not be identical with one of the forms described in this paper, but the description does not warrant devoting time and space to conjectures concerning it.

The following are the additions to this list made in Prof. Verrill's paper (17) above alluded to:

Styela partita (Stimpson).	*Microcosmus miniatus.*
Styela canopoides Heller.	*Polycarpa multiphiala.*
Halocynthia rubrilabia.	*Diazona picta.*
Halocynthia riiseana (Traustedt).	

Of these, four were new species. All save the last named are Simple Ascidians. Prof. Verrill also mentions the occurrence of the following genera, *Leptoclinum*, *Distaplia*, *Distoma* and *Amaroucium*, though naming no species.

One of these, *Styela canopoides* Heller, is, I think, included on insufficient evidence, while the Bermuda representatives of two of the others, *Styela partita* (Stimpson) and *Halocynthia riiseana* (Traustedt) differ sufficiently from the types to be considered as new subspecies.

Omitting *Styela canopoides* and the doubtful *Didemnum inerme*, there remain a total of eleven species recorded from the islands. Of these six are Simple and five Compound Ascidians, according to the classification I have adopted in this paper, in which the Clavelinidæ and Perophoridæ are regarded as Compound Ascidians. Only one of these, *Symplegma* (unfortunately the most interesting of them), is wanting from the Yale collections.

This is no inconsiderable number if the small geographical area under consideration is taken into account, yet a study of the collections made in 1898 and 1901 enables me to increase it to no less than 38 species, one of which is represented by at least six well-marked varieties and another by three, in addition to the type. As these varieties differ sufficiently to constitute species if intermediate forms did not occur, we have 46 as the total number of kinds of tunicates known to occur at Bermuda. They are distributed as follows in 23 genera (4 new) and 9 families.

COMPOUND ASCIDIANS.

Clavelinidæ.

Clavelina (*Stereoclavella*) *oblonga* Herdman.
Rhodozona picta (Verrill).

Perophoridæ.

Perophora viridis Verrill.
Ecteinascidia turbinata Herdman.

Distomidæ.

Distoma capsulatum, n. sp.
Distoma convexum, n. sp.
Distoma obscuratum, n. sp.
Distoma olivaceum, n. sp.
Distoma clarum, n. sp.
Cystodytes draschii Herdman.
Cystodytes violaceus, n. sp.
Distaplia bermudensis, n. sp.

Polyclinidæ.

Amaroucium bermudæ, n. sp.
Amaroucium exile, n. sp.

Didemnidæ.

Didemnum solidum, n. sp.
Didemnum savignii Herdman.
Didemnum atrocanum, n. sp.
Didemnum porites, n. sp.
Didemnum lucidum, n. sp.
Didemnum orbiculatum, n. sp.
Leptoclinum speciosum Herdman, represented at Bermuda by six new subspecies: *bermudense*, *pageti*, *hamiltoni*, *harringtonense*, *acutilobatum*, and *somersi*.
Polysyncraton amethysteum, n. sp.
Diplosoma macdonaldi Herdman.
Diplosoma lacteum, n. sp.
Diplosoma atropunctatum, n. sp.
Diplosomoides fragile, n. sp.
Echinoclinum verrilli, n. sp.

Botryllidæ.

Botrylloides nigrum Herdman, represented by three new subspecies: *concolor*, *planum*, and *sarcinum* in addition to the typical form.

Symplegma viride Herdman.

Polystyelidæ.

Michaelsenia tincta, n. sp.

Diandrocarpa botryllopsis, n. sp.

SIMPLE ASCIDIANS.

Halocynthiidæ.

Polycarpa obtecta Traustedt.

Styela partita (Stimpson) var., *bermudensis*, nov.

Halocynthia rubrilabia Verrill.

Halocynthia riiseana (Traustedt) var., *munita*, nov.

Microcosmus miniatus Verrill.

Ascidiidæ.

Ascidia atra Lesueur.

Ascidia curvata Traustedt.

The writer does not believe that this list by any means exhausts the number of forms really found there. The collections were made during the spring months. Collecting at other seasons would probably result in finding new species and larger and better specimens of many of those which are here described. Moreover, different methods of collecting might further increase the number.

A few words in defense of the somewhat appalling number of new species (21) are probably called for. The writer believes that our knowledge of certain families, notably the Didemnidæ, Halocynthiidæ, and Botryllidæ, has been retarded rather than advanced by the practice of many authors of describing as a new species nearly every faded and shrunken specimen that comes into their hands, because it cannot be made to agree perfectly with descriptions of other authors, made in many cases from similarly poor and scanty material. Such specimens had far better be left undescribed, unless they present characters so marked, that there is not likely to be much difficulty in identifying the form again, and characters of

such a nature that it is reasonably certain that they are not merely individual peculiarities of the specimen.

Minute and careful description cannot make up for insufficiency of material. Indeed it often decreases rather than increases the possibility of positively recognizing the species again if the individual peculiarities of the specimen be described as specific characters, and if no indication is given in regard to the directions in which individual variation (which is vastly greater in the ascidians than most writers give credit for) may be expected to manifest itself.

In the case of some Bermuda forms, the amount of material available has not been as great as could be desired, yet in nearly all cases I have had several specimens collected at different times and places. In two cases only have I ventured to describe a species on the strength of a single colony (*Didemnum solidum* and *Diplosoma atropunctatum*), and these only where there were well-marked specific characters, and when I had examined the specimen in a living state. In fact, there are only two or three of the forms which I have not myself collected and studied in a fresh condition.

The almost total neglect of the Compound Ascidians of this part of the world by previous collectors and investigators sufficiently explains, I think, the large number of new species in that group.

Methods of Collecting.

Most of the species may be found attached to stones along the shores of the bays and harbors, at low water. They grow chiefly on the under sides of stones of sufficient size to resist the movement of the waves and currents to which they are exposed. In such situations, as well as in narrow crevices in the rocks, they are safe from the attacks of the fishes and larger animals of other kinds which would otherwise destroy them.

The limestone rock, of which the islands are composed, contains numerous caverns to which the sea water has access through narrow passages where there is always a current of water when the tide is rising and falling. About the mouths of these passages (as at Waterloo, on Castle Harbor) are the best collecting places, not only for ascidians but for many other forms of invertebrates as well, as the constant currents of water carry an abundant supply of the minute organisms on which they feed. In such places it is not uncommon to find five or six different species of ascidians attached to the under side of the same stone. Sometimes several forms of Compound Ascidians may be found attached to an individual of one of the larger Simple Ascidians (Fig. 130).

A few species are seldom to be found along the shore, but grow chiefly on the corals, sponges, gorgonians, etc., on the reefs or in water deep enough to escape the effect of the waves and tides. These were obtained in collecting the corals and gorgonians by diving or by means of the nippers, attached to a long pole, which are used for that purpose.

Rhodozona picta (Verrill), *Distoma olivaceum*, *Cystodytes draschii* Herdman, *Distaplia bermudensis*, *Amaroucium bermudæ*, *A. exile*, and *Botrylloides nigrum* var. *concolor* are among the forms which are partial to such situations.

As far as I know, no ascidians are to be found on the white shell sand which covers large areas of the bottom in the sounds and harbors about the islands. So rough and rocky is the bottom in most other places that but little dredging was done, and this did not add any new forms to the list of tunicates.

It is possible that in the vicinity of the outer reefs there may be bottoms where a dredge can be used to advantage, and would probably disclose the existence of other species, particularly of the Polyclinidæ, which are partial to deeper water and are but poorly represented in our collections. Moreover, owing to the strong winds and rough water prevailing during the spring season (when all the collections were made), no collecting was done on the outer reefs. As many forms of invertebrates occur there which are seldom found on the reefs near shore, there are probably other kinds of ascidians there also.

Note.—The names of places, given as the localities where the specimens were found, are those of places about the Bermuda Islands, unless otherwise stated.

Methods of Preservation and Study.

Most of the specimens were preserved in formalin of from 2 to 4 per cent. This preserves the form and to some extent the color of the specimens better than any other method, but for anatomical study alcoholic specimens are usually better, though more contracted.

The specimens were studied microscopically by dissecting out the zoöids or parts and staining and clearing in glycerine; also by means of paraffin sections of the zoöids, or of the colonies, or parts of the same. Generally the specimens must first be decalcified. Owing to the absence of silicious sand at Bermuda, no trouble was met with in cutting the sections.

New Genera.

Diazona picta Verrill requires a new genus, which I have termed *Rhodozona*. It is in many respects intermediate between *Diazona* and *Clavelina*. In the general shape of the colony it is not unlike *Stereoclavella australis* Herdman (8) from Australia, but only the anterior portions of the zoöids project from the common test, and the colony has the beautifully transparent and gelatinous character of a *Diazona*. The branchial sac resembles *Clavelina* in the absence of internal longitudinal bars, but the strong longitudinal muscle bands along each side of the dorsal lamina, and the many transverse muscle bands in the mantle are very different from any species of that genus with which I am familiar.

The genus *Echinoclinum* is also an intermediate form, serving to unite more closely the genera *Didemnum* and *Diplosoma*, and furnishes an additional argument for uniting the Didemnidæ and Diplosomidæ in one family. In its zoöids and in the gelatinous nature of the colony, it resembles the last named genus or family. The large cavities present in the test in that genus are however wanting, and the large tetrahedral spicules, though peculiar in their shape and arrangement, are more suggestive of the former genus.

The two new genera of the Polystyelidæ, *Michaelsenia* and *Diandrocarpa*, appear to be connecting forms linking that family with the Halocynthiidæ and Botryllidæ respectively. In the latter genus one or more of the forms included by Michaelsen (12) in his genus *Gynandrocarpa* may also be placed, though the Bermuda form approaches the genus *Botryllus* more closely in the general character and pigmentation of the colony than any of the other species.

Classification.

The classification employed is based upon that of Herdman, but with a number of modifications, such as separating the Perophoridæ from the Clavelinidæ, and uniting the Diplosomidæ with the Didemnidæ, as many writers have done. Moreover, I include the Clavelinidæ and Perophoridæ among the Compound Ascidians, because they are compound. They reproduce by budding and form colonies, and are by no means so closely related to the Simple Ascidians as some of the Polystyelidæ are, though Herdman includes these among the Compound Ascidians.

I have made free use of Herdman's diagnoses of families and genera, as given in his Revised Classification (7), with many changes and omissions, and wish to acknowledge my obligations to that author.

Before proceeding to the description of the species, I wish to express my thanks to Prof. A. E. Verrill for the use of his material and for much valuable advice and assistance. I am also indebted to Prof. H. C. Bumpus and Prof. H. M. Smith, of the United States Fish Commission, for the opportunity of working at the Fish Commission laboratory at Wood's Hole, where a portion of this work was done, and also to Prof. S. I. Smith and Dr. W. R. Coe of Yale University, and Mr. T. Goodwin Gosling of Hamilton, Bermuda.

WILLARD G. VAN NAME.

New Haven, Conn., December, 1901.

Descriptions of Species.

ASCIDIÆ COMPOSITÆ.

Fixed ascidians which reproduce by gemmation, forming colonies the individuals of which remain united together by stolons or by being more or less completely buried in the common test. This group is usually regarded as a sub-order.

Family CLAVELINIDÆ Forbes, 1853

Body attached by the posterior end or more or less entirely buried in a creeping basal stolon or common stolonial mass, from which the young zoöids form by gemmation. Test usually gelatinous, apertures simple, or (rarely) lobed.

Branchial sac not folded, with or without longitudinal bars.

Dorsal lamina represented by or provided with languets.

Alimentary canal extending beyond the thorax to form a distinct abdomen.

Reproductive organs in or beside the intestinal loop.

Genus Clavelina Savigny, 1816.

Zoöids oblong or club-shaped, nearly independent, each enveloped in its own test and connected by stolons arising from the posterior end.

Apertures not lobed. Mantle muscles mainly longitudinal.

Branchial sac with straight stigmata, with no internal longitudinal bars or papillæ, but with horizontal membranes.

The Bermuda species of this genus belongs in Herdman's subgenus *Stereoclavella*, which differs from the typical *Clavelina* in having the stolons united in a basal thickening or mass of test.

Clavelina (Stereoclavella) oblonga Herdman.

Clavelina oblonga Herdman, Prelim. Rep. Proc. Roy. Soc. Edin., 1879–80, p. 724.
Clavelina oblonga Herdman, Report Voy. Challenger, Zoöl , vol. vi, pt. xvii, p 246, plate xxxv, figs. 6–10.
Stereoclavella oblonga Herdman, Trans. Biol. Soc Liverpool, vol. v, pp. 160–161, also Jour. Linn. Soc Zool., vol. xxiii, p 608

Plate XLVI. Figure 1. Plate XLVII. Figure 7.
Plate LXII. Figure 180*a*.

Individual animals club-shaped, the anterior end rounded, the body tapering gradually into the very short stalk. The colony consists of a number of such individuals quite closely grouped together, united by the expanded bases of the stalks.

The total length of the largest individuals (including the short stalk) is about 30^{mm}. Removed from the test the zoöid ordinarily measures less than half this length, but large ones fully expanded measure about 20^{mm} in length.

The test is thick but perfectly transparent and colorless; the lower part may be slightly incrusted with fine sand. It is gelatinous in consistency, firmer near the base. The zoöids themselves are nearly colorless. The stomach and intestine in life are brownish. There are often spots of very pure opaque white on the thorax, and always about the edges of the orifices.

The musculature of the mantle consists of a rather small number of slender bands, most distinct on the thorax. Beneath there are very delicate transverse muscles placed close together. These form an almost continuous but very thin layer about the thorax, but the longitudinal muscles are much the stronger and the animals contract greatly in length in preservation. The thorax contracts more than the abdomen. In life when the animal is expanded the branchial sac is fully half the length of the body.

There are 15 or more rows of stigmata, and sometimes 50 in a row. The stigmata begin close beside the dorsal lamina.

According to Herdman, the dorsal languets are short, conical and tentacular, and separated by about their own length. The tentacles are short and stout, about 20 in number, of two sizes placed alternately. The dorsal tubercle is small and irregularly oval.

In all the specimens obtained the reproductive organs were small, but a large number of embryos in various stages were contained in the atrial cavities of some of the zoöids.

This is a common species. It was obtained both in 1898 and 1901, also by Prof. Goode, as well as by the Challenger Expedition. The writer has collected it in Castle Harbor and on the north shore of Coney Island, where a number of colonies were found under stones a little below low water mark.

Genus **Rhodozona,** n. gen.

An examination of *Diazona picta* Verrill (17) shows that it differs so materially from the type of *Diazona* that it must be made the type of a new genus, having characters intermediate between *Diazona* and *Distoma* or *Clavelina*.

It differs from the former genus in having the colony divided up into a large number of small lobes, in the absence of internal longitudinal bars from the branchial sac, and in having no lobes to the apertures. It has a smooth-walled stomach, except for a single longitudinal ridge on the inner surface.

Rhodozona picta (Verrill).

Diazona picta Verrill, Trans. Connecticut Academy, vol x, pt 2, pl. lxx, fig 8, 1900.

PLATE XLVI. FIGURE 8. PLATE XLVII. FIGURE 5.
PLATE LX. FIGURE 122

"Forms large gelatinous colonies, consisting of a massive main stem from which arise more or less numerous lobes, each lobe often containing 12 to 20 zoöids, which, in expansion, are much exsert above the common mass, the free portion being slender and three or four times as high as broad. Apertures, when expanded, on short terminal tubes, the oral one larger and higher than the atrial.

"General color usually translucent pinkish white; the oral aperture surrounded by a band of bright carmine-red, edged on both sides with flake-white; a stripe of the same carmine color extends from the oral band down the ventral side of each zoöid.

"Height of the larger colonies, 125 to 160^{mm}; breadth about the same; height of free part of zoöids, in life, 15 to 20^{mm}; their diameter, 5 to 6^{mm}; diameter of oral tube, about 2^{mm}." (Verrill 17.)

The test is gelatinous and transparent and of similar character to that of *Diazona*. In young colonies and in newly developing lobes of larger colonies, where the zoöids are still small, they do not project above the surface of the lobe. Such specimens may, however, be readily identified by the color and the great numbers of anasto-

mosing vessels with enlarged ends, which occur in the lower parts of the colonies. These vessels arise from the posterior ends of the zoöids.

The largest zoöids measure, in the preserved condition, about 22^{mm}, or slightly more, in length when removed from the test. In formalin they are of a pale flesh-color. The white contents of the intestine show plainly from the outside.

The mantle is provided with a varying number of rather narrow longitudinal muscle-bands. Beneath these bands there are still narrower transverse bands of different sizes, which are spaced rather far apart, so as to form with the longitudinal muscles square or oblong meshes often of considerable regularity. (Fig. 5.) On the abdomen, the musculature becomes weak and inconspicuous. The siphons have delicate longitudinal and sphincter muscles. The apertures are not lobed, but in contraction their edges become thrown into folds which may easily be mistaken for lobes.

There are fifteen or more rows of stigmata in the branchial sac, each with a great number of short but narrow and closely placed stigmata. The transverse vessels are muscular and have very wide membranes attached along their inner sides. These membranes unite with each other and with the rather long tapering dorsal languets at the dorsal lamina. The dorsal lamina itself is rather broad, and has a thick muscle-band along each side.

There are about a dozen tentacles placed rather far apart and forming a single circle in which large and small ones alternate, but in addition to these there are numerous much smaller ones inserted farther forward and apparently forming more than one circle. In this it resembles the genus *Distoma*. There are no atrial tentacles.

The stomach is smooth-walled and elongated. It is provided with a single internal ridge running longitudinally, and a similar ridge may be traced along a large part of the intestine.

The reproductive glands are poorly developed in the specimens in the collection. The ovary is elongated and situated in the loop of the intestine, and in most cases contains numerous small eggs, but no large eggs or embryos were found. There is a well developed oviduct.

"Harrington Sound and Castle Harbor, just below low-tide, usually attached to gorgoniæ or bryozoa" (Verrill). One or two large colonies, and many small ones, were collected in 1898; but in 1901 only a few small ones were found. It appears to grow chiefly on the gorgonian *Muricea muricata*.

Family PEROPHORIDÆ Giard.

Distinguished from the Clavelinidæ chiefly by the absence of an abdomen.

Branchial sac with from four to many rows of stigmata, either plain or with papillæ or longitudinal bars. The dorsal lamina may be a continuous membrane, but languets are usually present.

The stomach and intestine lie on the left side of the branchial sac.

Reproductive organs in the intestinal loop.

Genus **Perophora** (Lister, 1834), Wiegm., 1835.

Body short and wide, the branchial sac with but four rows of long, narrow stigmata. Both apertures lobed.

Branchial sac with papillæ (which are often branched) on the transverse vessels, but no internal longitudinal bars. Dorsal lamina with languets.

Perophora viridis Verrill.

Perophora viridis Verrill, American Jour. Science, ser. iii, vol. ii, p. 359, 1871; also Rep. of Comm. Fish and Fisheries, (Invertebrate animals of Vineyard Sound, etc.), p. 702, 1871–72, also Webster's International Dictionary, pp. 1065, 2004 (figures).

See also Lefevre, Budding in *Perophora*, Jour. of Morphology, 1898.

PLATE XLVII. FIGURE 8.

"Colonies composed of nearly sessile individuals about 2.5^{mm} to 3^{mm} high, connected by slender stolons, and thickly covering the surfaces over which they creep. Test compressed; seen from the side, scarcely higher than broad, oval, elliptical or sub-circular, often one sided or distorted, with a short pedicle or subsessile at base. Branchial orifice large, terminal; anal lateral or subterminal, both a little prominent, with about 16 angular lobes, alternately larger and smaller. Test transparent; mantle beautifully reticulated with bright yellowish green; intestine yellow." (Verrill.)

There are a dozen or more tentacles of two sizes placed alternately. The horizontal bars of the branchial sac bear one papilla for every two stigmata except near the ends. Testis usually consisting of several separate glands.

Specimens of *Perophora* from Bermuda do not appear to differ in internal structure from this well known species of the New England coast. The colonies collected were all small, with but few individuals, and these were lighter colored and rather more transparent

than the average of a large number of specimens collected at Wood's Hole, Massachusetts. They were rather yellower in color during life and appear to be somewhat less compressed laterally, though this may be partly due to the fact that the zoöids are in no case crowded together, the colonies being loose and straggling.

The writer collected specimens in May, 1901, under stones at various points, including Waterloo, on Castle Harbor, Coney, and Long Bird Islands, Somerset Island, and Hungry Bay. It is widely distributed, but at that season of the year, at least, it is not very abundant or conspicuous.

Genus **Ecteinascidia** Herdman, 1880

Body elongated, usually tapering posteriorly, sometimes with a short peduncle; but not divided into thorax and abdomen. Test thin and membranaceous, containing no blood vessels.

Mantle thin, musculature consisting of transverse bands.

Branchial sac with internal longitudinal bars which are not papillated.

Dorsal lamina usually represented by a series of tentacular languets.

Viscera placed on the left side of the branchial sac.

Ecteinascidia turbinata Herdman

Ecteinascidia turbinata Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., p. 724, 1879-80.

Ecteinascidia turbinata Herdman, Report Voy. Challenger, part xvii, p. 243, pl. xxxvi, figs. 1-6.

See also Lefevre, Budding in *Ecteinascidia*, Anat. Anzeiger, vol. xiii, 1897.

PLATE XLVII. FIGURES 4 and 6. PLATE LIX. FIGURE 116.

Prof. Verrill (17) states that he found this species in 1898. There were, however, no specimens among the ascidians he brought home.

In 1901 the writer found what he considers to be immature specimens of this species, but no adults.

The following is condensed from Herdman's description of the adult:

Shape of each individual elongated, the anterior three-fourths almost cylindrical, the posterior part tapering rapidly to a short, slender stalk. Apertures sessile and minute, both at the right side of the anterior end. They are not lobed.

Length of body 30^{mm}, breadth near the anterior end 10^{mm}. Test thin and membranaceous, transparent. Internal longitudinal bars of

branchial sac narrow and borne on stout connecting ducts. No horizontal membranes present. The meshes between the internal longitudinal bars contain two or three stigmata On each side of the dorsal lamina (which consists of a row of narrow tentacular languets) there are no internal longitudinal bars for a space of about ten stigmata, but there is a papilla on each transverse vessel at about half this distance.

Tentacles simple and filiform. They are of three lengths placed regularly. Dorsal tubercle elongated and tapering posteriorly. Its aperture is anterior, and the horns are coiled.

Genital glands in the intestinal loop. Ovary alongside and curved parallel to the intestine. Testis in the concavity of the ovary.

The young individuals obtained by the writer do not exceed 6^{mm} in length. Most of them are smaller. The test and mantle are very transparent and the latter contains branching vessels similar to those in *Perophora*.

In life the color is a pale greenish yellow, due to corpuscles of that color in the vessels of the branchial sac and mantle. It becomes brown in preservation.

The body and branchial sac are much shorter than in the adult; none have over 18 or 20 rows of stigmata There are two sizes of tentacles. The apertures appear lobed, but these may merely be folds produced by contraction of the strong sphincter muscles.

None of the individuals had reproductive organs developed.

The type specimen of this species was obtained by the Challenger Expedition at Bermuda in shallow water. Herdman also states that there are several colonies in the Liverpool Free Public Museum from Alexandria Harbor (3 to 5 fathoms). It also occurs at Jamaica (Lefevre 9).

The young specimens collected at Bermuda by the writer were mostly found under stones along the shores of Castle Harbor and at Coney Island, during the month of May.

Family **DISTOMIDÆ** Giard, 1872.

Colony generally thick and massive, sometimes pedunculated. Systems often wanting. Zoöids usually completely imbedded in the common test.

Zoöids having the body divided into two distinct regions,—thorax and abdomen. From the posterior part of the latter vascular processes usually extend into the test, and upon these the buds form.

Branchial sac without internal longitudinal bars or folds. Dorsal lamina in the form of a series of languets.

Reproductive organs in or on one side of the intestinal loop. Testes consisting of a number of separate pyriform glands. Vas deferens not spirally coiled.

This family is none too well separated from the Clavelinidæ. On the other hand the adult zoöids of this family much resemble those of the Didemnidæ, but the last named family has an entirely different method of budding and is in reality only distantly related.

Genus **Distoma** Savigny, 1816

Colony generally thick and fleshy. Systems sometimes present. More often both orifices of the zoöids open independently on the surface and the zooids are irregularly placed. No calcareous spicules.

Branchial orifice normally six-lobed. Atrial orifice also with six lobes and placed at the end of a distinct tubular siphon.

Tentacles often very numerous; in more than one circle.

Stomach globular. Intestinal loop more or less twisted.

Reproductive organs on the left side of the abdomen, which is separated from the thorax by a more or less elongated and narrow peduncle. No incubatory pouch is present, though the embryos develop under the mantle of the parent.

The stomach is smooth-walled in the Bermuda forms.

The zooids in this genus are quite elongated, but the mantle is strongly muscular, and in preserved specimens they are apt to be so contracted as to give little idea of their natural shape. This must be taken into account in identifying specimens of these animals.

For the purposes of illustrating this paper, individuals were selected which were not much contracted.

Analytical Table of Bermuda species of Distoma, based on the character of the colony.

A.—Incrusting, but thick. Surface uneven, usually slightly raised over the positions of the zoöids. Test firm, colorless but rendered more or less opaque by included sand and shell fragments, which are usually most numerous immediately about the zoöids, forming a sort of capsule. Zooids large, not pigmented. *D. capsulatum.*

B.—Massive, rounded, attached by most of lower surface. Upper surface smooth and shining. Test soft and gelatinous, with brown or dusky pigment, yet more or less transparent. Much sand included in lower portions of colony. Zoöids rather large with more or less rich brown pigment. *D. convexum.*

C.—Flattened and incrusting but rather thick. Test firm, color greenish black, entirely opaque. Surface smooth. Zoöids rather large, with much black pigment *D. obscuratum.*

D.—More or less completely divided into heads raised on short peduncles (small colonies consisting of a single head). Color some shade of greenish yellow or olive. Upper surface of heads smooth and glistening. Zoöids of moderate size, somewhat pigmented, and more or less distinctly visible through the test. *D. olivaceum.*

E.—Rounded, attached by most of lower surface. Test very transparent, usually colorless, soft and gelatinous. Zooids small with the thorax usually pure white and the intestinal loop orange, conspicuously visible through the test. *D. clarum.*

Distoma capsulatum, n. sp

PLATE XLVI. FIGURE 2 PLATE LVIII. FIGURE 107.

Forms a small rounded or unsymmetrical colony with an uneven surface, which is often slightly raised over the anterior ends of the zoöids. Size of largest colony; 17^{mm} by 11^{mm} across, and 5 to 7^{mm} in thickness.

Test colorless, rather tough and firm, containing many included grains of sand and shell fragments, so that it may become entirely opaque. The zoöids lie in the test inclined at various angles, and are often so surrounded by sand grains or shell fragments, that each appears to be inclosed in a tubular calcareous capsule. In some specimens the whole of the colony is so crowded with included material that no such arrangement is noticeable. Some sand generally adheres to the surface of the colony also. The zooids do not appear to be arranged in systems.

Though all the colonies found were very small, the zooids were large and few in number. When removed from the test they are light yellow or buff with the stomach and part of the intestine orange. They often reach 6^{mm} or more in length in the preserved specimens, which are of course somewhat contracted.

The mantle is well provided with longitudinal muscles, which are gathered on the thorax into a rather small number of broad but not very compact or solid bands. These may also be traced some distance back from the thorax, but gradually break up into narrow bands or individual fibers toward the posterior end of the zoöids. Beneath these longitudinal muscles on the anterior half of the body there are fairly strong transverse muscles, which are, however, not

collected into definite bands. The sphincters of the siphons are well developed. The lobes of the branchial opening are often somewhat bifid.

The branchial sac has four rows of narrow stigmata with a considerable number in each row. The tentacles are numerous, of several sizes arranged in more than one circle, somewhat after the manner described below in *D. convexum*.

The intestinal loop is twisted bringing the large globular stomach to the dorsal side of the abdomen. The so-called hepatic gland surrounding the intestine is confined to a very short portion of its length and consists of short tubules of rather large diameter with expanded ends closely clasping the intestine. (Fig. 2.)

The pyriform testes are very numerous, often 20 to 30 in number. None of the specimens examined contained large eggs or embryos

This is not an abundant species. Five small colonies were collected in 1898 attached to the lower part of a mass of coral. The writer also obtained several colonies at Coney Island, Bermuda, in May, 1901, below extreme low water mark, attached to stones. These were in poor condition, with very few and small zoöids.

The species is probably commoner in deeper water than along the shore.

Distoma convexum, n. sp.

PLATE XLIX. FIGURE 16 PLATE LVIII FIGURE 104. PLATE LIX. FIGURE 118.

Colony forming a thick, fleshy, rounded mass attached by a large part of the lower surface.

The largest colony obtained measures about 24^{mm} across and fully as much in greatest height. The others are of proportionately less height.

The upper portion of the colony is free from included material and the surface is smooth and glistening, but in the lower parts there are many sand grains and shell fragments. The color of the test is a smoky brown or dusky brown (due to scattered cells containing the pigment), very soft and gelatinous yet transparent, so that the zoöids can be more or less distinctly seen. They are numerous and closely placed, but no systems can be distinguished, at least not in the preserved specimens. Bladder cells appear to be absent from the test.

The zoöids are perceptibly smaller than in the last described species (*D. capsulatum*), the individual figured measuring 4.9^{mm} in

length by 1^{mm} across, when somewhat contracted. Their tissues are yellow, the stomach orange, and in addition many of the cells in the mantle contain brown pigment grains of irregular shape, especially on the anterior part of the thorax.

The musculature (not shown in fig. 16) is similar to that of *D. capsulatum* though the longitudinal bands are rather more numerous, and as in that species, it becomes very weak on the abdomen.

The branchial sac has four rows of stigmata, the number in a row exceeding 20 on each side. The tentacles are evidently arranged much as in *D. adriaticum* (Von Drasche, 3). There is a circle of eight large ones; a little further forward, and alternating with them, eight smaller ones; and still further forward one or more circles of still smaller ones.

The gland surrounding the intestine in this species differs from that of *D. capsulatum*. The tubules of which it consists run lengthwise of the intestine and lie parallel to each other, surrounding the intestine on all sides. As in the last mentioned species, they do not branch. Anteriorly they are of small diameter but increase in size as they follow the intestine backward. After following it some distance they leave it and run toward the stomach. At a point near the latter they converge and unite into the common duct. Along the intestine they are thin-walled tubes composed of an epithelium of flat hexagonal cells with nuclei which do not stain deeply. After leaving the intestine they become suddenly smaller, with thick walls and scarcely visible lumen, close to which the deeply staining nuclei of the cells are placed, and they are provided with a conspicuous basement membrane.

Two colonies were collected in 1898 and several in 1901. The exact localities were not recorded, but they were no doubt taken at points near the eastern end of the group of islands. One of the colonies contained a few larvæ.

Distoma obscuratum, n. sp

PLATE XLVIII. FIGURE 11. PLATE LVIII. FIGURES 105 and 106.

Two specimens of this species, which is nearly related to *D. convexum*, but evidently quite distinct from it, were collected in May, 1901, growing on corals in rather shallow water in Castle Harbor. They are of flattened form, measuring between 20 and 30^{mm} across, and are 3 to 4^{mm} in thickness, with rounded edges. They are of a uniform greenish black color, entirely opaque, and of firm semi-cartilaginous consistency.

In external appearance the colonies resemble those of *Cystodytes draschii* so closely that they were taken for that species until they were cut open.

Common cloacal apertures are present. The dark pigment of the test is contained entirely in the numerous test cells. The zoöids are pigmented much as described in the case of *D. convexum*, but the pigment is in this case much more thickly distributed and is of an intense black color, so that the whole thorax appears black. There is also much of the black pigment on the vessels of the branchial sac.

The zoöids average about the same size as those of *D. convexum*, though they appear to be somewhat less stout, and differ from them but very little in structure.

They have between 15 and 20 stigmata in a row on each side.

The tubules of the gland surrounding the intestine do not pursue parallel courses along the intestine as in *D. convexum*, but resemble rather those of *D. capsulatum*, though they are not so crowded together (fig. 11).

The colonies contain some tailed larvæ.

Distoma olivaceum, n sp

PLATE XLVIII. FIGURE 9 PLATE LIX. FIGURE 118.

This species is also closely allied to *D. convexum*, but the form of the colony differs. In this species it consists of a flat-topped more or less distinctly pedunculated head of small size, seldom over 5 to 8^{mm} across, and, including the peduncle, not much over 10^{mm} in height. Many of the heads are very small, but usually a number of them are grouped together in a mass which may cover several square centimeters of the stone or coral on which the colony grows, the separate heads being connected by the expanded lower ends of the peduncles. In shape the heads resemble those of *Distaplia*, but average smaller. Common cloacal apertures are probably present. Occasionally no distinct peduncle can be distinguished, the colony being attached by its lower surface, and in such cases it often becomes wider, though of less height than stated above.

The color also differs from that of *D. convexum* and is retained, at least for a considerable time, in specimens preserved in formalin or even in alcohol. It is some shade of olive, or yellowish olive, or in a few specimens a very dark olive-green. The test is moderately firm, the upper surface is smooth and glistening; the peduncle, however, is coated with an outside layer or pellicle containing fine sand

grains. This coating of sand generally ceases abruptly at the top of the peduncle. The interior of the colony is usually nearly free from sand or shell fragments.

The zoöids are light colored, with the stomach and part of the intestinal loop orange. The mantle is less pigmented than in *D. convexum*, the spots are blackish and exceedingly minute, and it is usually only on the anterior end just over the ganglion and over the end of the endostyle that they are sufficiently numerous to conceal the whitish ground-color of the mantle. These two points, however, are in most individuals practically black, so thick is the spotting, and they are visible through the semi-transparent test (especially in light-colored colonies) as black dots, and in many of the specimens are the most conspicuous parts of the zoöids.

In structure the zoöids resemble those of *D. convexum*. This applies also to the structure of the gland surrounding the intestine. They average, however, somewhat smaller and slenderer than those of *D. convexum*, as a comparison of figs. 9 and 16, drawn to the same scale, will show. There are the same number of rows of stigmata (four) but fewer in each row. There are also fewer tentacles. There are a dozen or more quite long slender ones, also some small ones inserted further forward.

None of the zoöids examined contained embryos in advanced stages, or very large eggs.

This species was not among those collected in 1898. In 1901, however, it was abundant, especially on corals in Harrington Sound, but common also under stones along the shore at various places, including Coney Island, Long Bird Island, and Hungry Bay. It appears, though, to prefer deeper water rather than situations near low-water mark.

Distoma clarum, n. sp.

PLATE XLVIII. FIGURE 10. PLATE LIX. FIGURE 117.

Colony jelly-like, the test usually colorless and transparent in preserved specimens. In life, however, it is slightly opalescent with a greyish, pinkish or sometimes a blue or green cast. The colony is simply a rounded or oval mass without a peduncle, attached by most of the under surface. It seldom exceeds 12^{mm} in width and half that in greatest thickness. The zoöids, which are irregularly placed and lie at all angles to the surface (no systems being discernible), are visible through the test with perfect distinctness.

The mantle of the thorax is pure white, not pigmented, while the stomach and more or less of the intestine is yellow or orange. This color fades out in preserved specimens, becoming yellowish or flesh color. In specimens which are in a degenerate condition, the test often becomes infested with parasitic algæ, giving it a dirty and greenish appearance.

Some specimens preserved in alcohol have the zooids very dark colored, brownish or blackish. I think this may be due to the action of the alcohol or of something contained in it. I have not seen fresh specimens in which they are so colored.

The zooids are much smaller than in any of the above species. The longitudinal muscles of the mantle are strong and form distinct bands. In consequence of this development of these muscles the zoöids are nearly always found in a condition of violent contraction. This is true of all the species of this genus, but particularly of this one, and most of the zooids in preserved specimens are generally contracted into a shapeless condition.

There are four rows of stigmata, but a rather small number in each row. Neither are the tentacles very numerous, but they are of two or three different sizes, the largest ones inserted farther back than the smaller ones. In some colonies seven lobes to the branchial aperture is the rule, in others six. The atrial aperture always has six as far as I have observed. There are fewer testes than in any of the larger species of this genus described above. Six appears to be a common number, but in some colonies it is often considerably exceeded.

Specimens of this species collected in April and May are full of large eggs and embryos in all stages. Four or five large embryos, together at least equalling in bulk the individual which has produced them, may sometimes be found under the mantle of one zoöid. Those of most advanced development are nearest the atrial aperture, the others further back, according to their stage of growth.

This species is abundant and may be found on the under side of stones at every suitable place along the shore, and on corals, etc., on the reefs. It is one of the two or three commonest ascidians at Bermuda.

Genus **Cystodytes** von Drasche, 1883.

Differs from *Distoma* in that the abdomen of each zoöid is surrounded by a capsule of calcareous spicules lying in the test. These spicules have the form of circular disks, thin at the edges and

thicker at a point near the center, and slightly concave on the side toward the zoöid. The capsule is formed by a varying number of such disks placed overlapping each other, sometimes several deep.

The zoöids are shorter than those of *Distoma*, and appear to have no vascular appendages. If this be the case, the method of budding must be somewhat modified from that of *Distoma*.

Cystodytes draschii Herdman.

Cystodytes draschii Herdman, Report Voy. Challenger, pt. xxxviii, p. 187.

PLATE XLIX FIGURE 17. PLATE LVIII FIGURES 99 to 101 inclusive.

The type of this species, described in the above work, was obtained in 400 fathoms off Barra Grande, Brazil, but Bermuda specimens from shallow water agree almost perfectly with Herdman's description and figures.

It forms flat incrusting colonies, about 5^{mm} thick, and reaching 60 or 80^{mm} across. The surface is smooth and the consistency of the test moderately firm. The colonies are usually quite opaque. The color is a deep, uniform, brownish gray. When the colony is cut the white calcareous capsules surrounding the posterior ends of the zoöids are very conspicuous.

Under the microscope the test is shown to contain enormous numbers of bladder cells, so closely packed in most places that their outline becomes polygonal, and the amount of test substance is actually small.

A spicule of ordinary size measures from 0.1 to 0.3^{mm} in diameter and about 0.03^{mm} in thickness at the thickest point, but somewhat larger ones and of course many smaller ones occur. They resemble the larger kind of spicules of *C. violaceus* shown in fig. 14.

The zoöids are pale yellow in color when removed from the capsule, which is not readily done without tearing them unless the capsule is dissolved away. They are distinctly divided into thorax and abdomen, but by a very short peduncle, if indeed there can be said to be any. In life, however, they must be capable of some extension, and their usual contracted condition is due to the great strength of the longitudinal mantle muscles. These form many distinct bands on the sides of the thorax, but in the region of the peduncle these separate bands run together and unite into a single broad, thick band on each side. On the abdomen, the muscles spread out again. The object of these strong bands is no doubt to retract the thorax and bring it more or less completely within the protection

of the calcareous capsule. The mantle contains a few black-pigmented corpuscles.

The tentacles are very slender and numerous, of two sizes, the shorter inserted, as in *Distoma*, in a separate and more anterior circle. There are four rows of stigmata with but a small number in a row. Both apertures are six-lobed.

This species is rather common in Castle Harbor; off Bailey's Bay; and doubtless in other places at Bermuda, on gorgonians, corals, etc.

Cystodytes violaceus, n. sp.

PLATE XLVIII FIGURES 12, 13 and 14

Four small colonies of a species of this genus, evidently distinct from *C. draschii*, were obtained in Castle Harbor, at Waterloo, in May, 1901. The largest measures only about 12^{mm} across and not much over 2^{mm} in thickness. They were attached to the under side of a stone.

The test is semi-transparent, allowing the zooids, or rather their capsules, to be seen, and contains corpuscles with purple pigment, which becomes brown in preserved specimens. The zoöids have the stomach yellow, but no pigment cells in the mantle.

The spicules forming the capsules about the zoöids resemble those of *C. draschii*, and reach a diameter of about $.3^{mm}$, but the capsules are less perfect, and in addition there are spicules scattered in the lower layers of the test and taking no part in the formation of the capsules. They are most numerous and conspicuous near the edges of the colony. Most of them are of smaller size than those forming the capsules, being usually only about one-fifth or one-sixth of the diameter of the latter, and they are proportionately thicker, with thick rounded edges, and are readily seen to be built up of radially disposed rods or needles. The spicules of the capsules also have radial striations or markings, but they are much less distinct. (Figs. 13 and 14.) Bladder cells occur in the test, but much less abundantly than is usual in *C. draschii.*

The zooids are similar to those of that species, but average a little smaller and generally have a smaller number of testes. Many of them contain large eggs in the abdomen.

Sluiter's figures and description (15) show that there is a very striking resemblance, superficially at least, between this species and his *Diplosoma purpureum*, found at Cape Verde, Africa. Though he may have sufficient reason for placing his specimens in the genus

Diplosoma, it must be admitted that he gives nothing, either in the figures or description, which demonstrates or even supports the correctness of his position, and in his figure the numerous bladder-cells and the objects which he considers included "shells of Globigerinas" bear a most extraordinary resemblance to the bladder-cells and spicules of *Cystodytes*. Moreover, in his description he indicates the existence of a number of testes. *Diplosoma* has but two.

The European *Cystodytes dellechiaiæ* Della Valle has also a violet color, and I do not feel very sure that the species here described is really distinct from it.

Genus **Distaplia** Della Valle, 1881.

Colony fleshy, often lobed or pedunculated. Test penetrated by vascular processes of the zoöids. Zoöids arranged in distinct and usually rather simple systems.

Branchial sac large, with four rows of long stigmata.

Atrial aperture with a large languet.

Stomach ovate. Intestinal loop not twisted.

Reproductive organs on the right side of the intestinal loop.

The larvæ in this genus are remarkably large. The eggs are received into an elongated diverticulum of the atrial cavity which is developed for the purpose, the incubatory pouch, where they undergo development. The youngest embryos are always found in that end of the pouch farthest from the body of the parent.

Distaplia bermudensis, n. sp.

PLATE XLIX. FIGURES 15, 18 and 19. PLATE LIX. FIGURES 108 and 111. PLATE LXII. FIGURE 180*b*.

Specimens of *Distaplia* from Bermuda are very variable in respect to the form and color of the colony, yet I cannot find ground for believing that more than one species occurs there. Bancroft (1) reports a similar variability in the Pacific species, *D. occidentalis*. There is reason to suspect that the number of species of this genus occurring in European waters has been considerably overrated, through failure to make allowance for such variations.

I am unable to identify these specimens with any of the species already described. Some of the colonies closely resemble *D. vallii* Herdman (6), but it is doubtful whether that is a good species, and moreover, if the stomach of that species resembles that of *D. magnilarva* Della Valle, as Herdman says, it must be pitted or folded on the inner surface.

The Bermuda form has the stomach smooth-walled within and without, though, when highly magnified, the inner surface is finely granular. No pits or folds are present, except such as may be produced by the contraction of the body, the stomach-wall being very thin and delicate. The smooth-walled stomach is, as far as I know, peculiar to this species.

Some of the specimens have the form of rather flat-topped heads, with more or less abrupt edges, attached by a short peduncle. Such heads are usually 10 or 12^{mm} across the top and (including the peduncle) 12 or 15^{mm} in height, and they often consist of but a single system. Other colonies (figs. 18 and 19) form rather thick but flattened incrusting masses several centimeters across, attached by the greater part of the lower surface. Between these and the heads there is every gradation. The incrusting colonies usually contain several systems, and may be produced into one or more lobes, or more or less distinct heads.

The test is only moderately firm, but the outer layer is somewhat tougher. It is rather opaque, yet the zoöids and the vessels may usually be distinguished. The latter occur chiefly in the peduncle and lower parts of the colonies. They seldom branch or anastomose, and their terminal portions are only slightly enlarged. The test may or may not contain groups or masses of bladder-cells.

No reliance whatever can be placed on the color of the colony as a specific character. Whatever may be the color, it generally becomes darker on the upper surface of the head or colony, especially about the atrial aperture or apertures, and paler on the sides of the colony and on the peduncle, if one is present. Sometimes the upper surface is nearly black, and some white pigment is often present about the orifices. Usually the colonies have a chocolate brown color: this often shades into olive, violet, purple, or rose color in some parts of the colony, or one of these colors may predominate. All these colors turn to a green, blue-green, or yellowish green, or sometimes a deep blue, when the specimen is preserved in formalin.

Two large colonies obtained in 1901 were deep orange-red, almost vermillion, shading to blackish about the atrial orifices. These colonies turned brownish in formalin. Among the specimens obtained by Prof. Verrill in 1898 were a few which were almost white, and others of a dull yellowish olive. These were preserved in formalin, with no notes as to their colors in life.

The zoöids are easily removed from the test. They appear to vary much in size, but this is no doubt largely due to a varying

amount of shrinkage. This is very likely to occur in preserved specimens, as the tissues of the zoöids are exceedingly delicate. Well-expanded individuals are beautiful objects, and the internal structure can be made out with greater ease than in any other of the Bermuda ascidians. The mantle is but slightly muscular, the fibers running chiefly obliquely and transversely. It is often more or less pigmented, at other times nearly colorless. The stomach and duodenum are always orange in fresh specimens. The largest and best preserved zoöids measure over 3^{mm} in length, and about 1.2^{mm} across the thorax.

The branchial sac has four rows of more than twenty long narrow stigmata on each side, which become shorter as the ends of the rows are approached. A very narrow intermediate transverse vessel crosses the stigmata half way between each principal transverse vessel. This is visible even in quite young buds, where the number of stigmata in a row is still much less than in the adult. The structure of the branchial sac agrees exactly with Herdman's (6) description of *D. rosea* and *D. vallii.*

The branchial orifice has an irregularly toothed margin. This is not apparent when the aperture is much contracted. The atrial opening is placed well back from the anterior end and is very large, with the anterior lip produced into a long pointed languet. There are about 16 tentacles of two sizes placed alternately, but their arrangement and number is not always exactly the same.

As already mentioned, the stomach-wall is not pitted nor folded, but is smooth within and without.

The zoöids are usually hermaphroditic, well-developed testes and eggs of considerable size being present at the same time. (Fig. 15.) Some, however, appear to have the organs of only one sex. Some colonies contain great numbers of buds and embryos, the latter usually contained in the long incubatory pouch, which eventually becomes detached from the zoöid. I have not observed more than three embryos in a pouch.

Family **POLYCLINIDÆ** Giard, 1872.

Colony usually massive, sometimes incrusting, sometimes lobed or pedunculated. Systems of various shapes, occasionally irregular or wanting.

Zoöids elongated antero-posteriorly, and usually divided into three distinct regions; the thorax, abdomen, and post-abdomen.

Branchial aperture 6 or 8 lobed, atrial aperture often with a languet.

Branchial sac generally long, with numerous rows of small round or oval stigmata. It may be papillated, but no internal longitudinal bars occur.

Dorsal lamina with languets.

Stomach-wall smooth or variously folded or pitted. Reproductive organs and heart situated in the post-abdomen. Testis represented by a number of small spermatic sacs.

Gemmation by division of the post-abdomen.

Genus **Amaroucium** Milne Edwards, 1841.

Distinguished by forming massive, often pedunculated colonies, with elongated zooids having long post-abdomens, usually six-lobed branchial siphons, the atrial aperture placed well forward, and a large atrial languet The stomach-wall is, usually at least, longitudinally folded, but in one of the Bermuda species this appears to be a very variable character. The post-abdomen is sessile.

This genus, though almost universally accepted by writers on Tunicata, is but poorly distinguished from *Aplidium* Savigny, which in its typical form has a sessile colony, shorter zoöids, often lacks the atrial languet, and has the post-abdomen separated from the abdomen by a more conspicuous constriction or peduncle. The atrial aperture is also said to be placed further back. Most of these differences are very trifling, and many species could be placed in either genus with equal propriety.

Amaroucium bermudæ, n. sp

PLATE L FIGURE 20. PLATE LVIII. FIGURES 96 and 97.

The colony is irregular in shape, seldom much over 30^{mm} across, generally less, with rather flat top and abrupt sides tapering into a more or less distinct peduncle. The combined height of the colony and peduncle often reaches 20^{mm} or more.

The test is firm, almost cartilaginous, but softer in the interior of the colony. It is usually quite free from sand grains, grayish and nearly opaque in life, sometimes with a distinct bluish or pinkish tint. In formalin it becomes more transparent and of a yellowish or flesh-color. There are no bladder-cells. The systems are irregular and the number of zoöids in different specimens of the same size is very variable.

The zoöids are rather large and stout. A fair sized specimen measures 2.3^{mm} long without the post-abdomen, which may itself reach 4 or 5^{mm} in length, though in most individuals it is much shorter. In color they vary from orange to bright vermillion red in life, but gradually fade to yellow in preservation. The color is diffused through most of the tissues, but in very red individuals the mantle of the thorax contains an especially large amount of pigment. The mantle, especially near the anterior ends of the thorax, abdomen and post-abdomen, is often studded with rounded cells, much larger than the ordinary epithelial cells.

Usually there are six lobes to the branchial orifice, but some individuals have more. There is a fairly large atrial languet placed a little anterior to the orifice, which is itself provided with distinct though very short lobes. The usual number of rows of stigmata appears to be about eighteen, with more than a dozen in a row on each side. They are small and round and placed rather far apart. The transverse vessels are very muscular. The tentacles are small and difficult to count.

The presence and arrangement of folds or plications in the wall of the stomach have been made the chief characters by which the genera of this family are distinguished. In the present species, however, it is clear that great importance should not be attributed to them. Usually the stomach of this form has distinct longitudinal folds, but often there are transverse folds also over more or less of the surface, or the transverse folds may even predominate and become the principal ones, exceeding the longitudinal folds in prominence. Some individuals show, on some parts of the surface of the stomach, an areolated condition not far removed from that which is typical of the genus *Morchellium* Giard. Others, again, apparently have the stomach entirely smooth-walled in its natural condition, but in this species the stomach-wall is very thin and liable to become folded by the contraction of the animal incident to preservation, and its original condition is not always easy to determine.

In another species of this genus, *A. constellatum* Verrill, from the New England coast, which normally has a longitudinally folded stomach, I have also observed variations from the usual condition, though not to such a great extent.

Many specimens of this species were collected, both in 1898 and 1901. It was found most abundantly on corals in Harrington Sound, in water of moderate depth, and evidently grows better in such situa-

tions than along the shore. The zoöids often contain larvæ in the atrial cavity.

In the Peabody Museum of Yale University there are some specimens of *Amaroucium* from Fort Macon, N. C., which appear to be of this species.

Amaroucium glabrum Verrill, from the coast of Maine, forms colonies of very similar size and shape.

Amaroucium exile, n. sp.

Plate L. Figure 21. Plate LVIII. Figure 98.

The colony in this species is rounded or button-shaped. It is not pedunculated and adheres by the greater part of the lower surface. The edges are not abrupt as in the last described form, but rounded, and the consistency of the test is not so firm. It does not generally grow more than 5 or 6^{mm} high and 15 or 20^{mm} wide.

The test is often quite densely crowded with coarse sand grains and shell fragments, in the interior of the colony as well as on the surface; in other cases it is entirely free from such inclusions and is very transparent and almost colorless. Such colonies are very beautiful objects, for the zoöids vary from orange to an even more brilliant red than those of *A. bermudæ*, being sometimes bright scarlet. The zoöids are smaller and slenderer than in *A. bermudæ*. The systems are irregular. The specimen figured measured a little under 4^{mm} long including the post-abdomen, which was short in this individual.

The chief anatomical differences between this and the last described species appear to be that the present one has fewer stigmata, only twelve or fourteen rows (the number in each row may be slightly less also), and that in this species the stomach-wall is thicker and always distinctly folded longitudinally with a variable but not very large number of folds (generally about 9).

This is a less common species than the last, and though found in the same situations, occurs under stones along the shore more frequently than *A. bermudæ* does. The writer collected it at Coney Island; Waterloo; and Somerset Island, among other places. It was obtained both in 1898 and 1901. Many of the specimens contain larvæ, which begin to secrete test-substance even while still contained in the atrial cavity of the adult zoöid.

This species is related to *A. constellatum* Verrill of the New England coast. The more brilliantly colored specimens of that

form are, when small, of rather similar appearance to those of this species; but the somewhat stouter zoöids, with much more numerous and often much less regular plications in the stomach-wall ; the very milky appearance of the test ; and the tendency to form wedge-shaped or pedunculated colonies, would serve to distinguish the New England species, even if it did not form massive colonies of vastly greater bulk than this species ever attains.

Family **DIDEMNIDÆ** Verrill, 1871

Colony incrusting, sometimes thick and massive, not pedunculated. Test usually containing bladder-cells and often calcareous spicules, which are generally of stellate form. Zoöids arranged in complex branching systems.

Zoöids of small size, divided into thorax and abdomen, often with a muscular and vascular process extending out into the test from the region of the peduncle connecting the two divisions of the body.

Branchial aperture six-lobed ; atrial plain, or with a languet. Three to six rows of stigmata. Dorsal lamina with languets.

Stomach smooth-walled, externally at least. Intestinal loop twisted.

Reproductive organs on the left side of the abdomen, or more or less ventral, or posterior. Testes few, often only one. Vas deferens often spirally coiled about the testis before leaving it to follow the intestine. There is no oviduct.

Budding from the pyloric region (near the peduncle); thorax and abdomen of the new zoöid formed from separate buds.

The genera *Diplosoma* and *Diplosomoides*, which are often regarded as constituting a separate family, the Diplosomidæ, are here included in this family.

Genus **Didemnum** Savigny, 1816.

Colony generally rather thick and fleshy. Test containing bladder-cells and usually stellate calcareous spicules.

Zoöids with a strong muscular process extending into the test from the ventral side of the peduncle connecting the thorax and abdomen. Branchial orifice six-lobed, atrial plain, with no languet.

Branchial sac with three rows of stigmata.

Testis single, more or less conical in form The vas deferens makes a number of spiral turns about it before proceeding on its

course to the rectum, which it follows to a point near the atrial orifice.

The Bermuda species of this genus differ more in the habit and character of the colony than in the structure of the zoöids or the form of the spicules. They appear to have the following characters in common:

The zoöids vary in length, according to the species, from less than 1^{mm} to 1.6^{mm} in preserved specimens. The musculature of the mantle consists of a moderate number (perhaps twenty or more) distinct, though slender, bands running longitudinally. Transverse muscles (with the exception of the sphincters) are but slightly developed in the mantle.

The transverse vessels of the branchial sac are, however, provided with strong muscles, and each side of the dorsal lamina a strong muscle-band runs longitudinally in the wall of the branchial sac. These two bands, which run ventrally when they reach the posterior end of the thorax, are joined near the posterior end of the endostyle by fibers from different parts of the wall of the thorax, so that they become quite thick, and passing out in a ventral and posterior direction from the upper end of the peduncle, they unite to form the muscle of the muscular process which extends out into the test.

The tentacles appear to be eight in number, four large and four small ones placed alternately, but I am not certain that there are not more in some cases. The stigmata are long and narrow, about 16 in number on each side in the species with the largest zoöids, and somewhat fewer in the smaller species. The upper and lower rows of stigmata do not contain quite as many as the middle row.

The stomach is round or oval and smooth externally, and more or less yellow in color. The gland about the intestine consists of a small number of tubes clasping it. They branch but little, and their terminal portions are not much dilated.

I have found well developed reproductive organs in only two species (*D. savignii* and *D. porites*), but they are probably similar in the others also. The testis, which is single and obtusely conical, is very large, and is situated on the left side of the abdomen, with its base close against the intestine. The vas deferens leaves it at its apex and makes, usually, from eight to a dozen turns about its conical surface, like the string wound around a top. It leaves it finally about opposite the stomach. The ovary is placed between the testis and the stomach.

Analytical Table of Bermuda species of Didemnum, based on the character of the colony.

A.—Massive and irregular, opaque, consistency firm. Surface roughish ; apertures far apart and conspicuous. Spicules uniformly and thickly distributed. Color reddish grey or buff, almost flesh colored. *D. solidum.*

B.—Moderately thick, opaque, gelatinous. Surface smooth and glistening ; apertures inconspicuous. Spicules confined to a stratum in the interior of the colony, invisible from above. Color rich brown. *D. savignii.*

C.—Very thin, incrusting, gelatinous; zoöids visible through the test. Surface smooth, apertures inconspicuous. Spicules irregularly distributed. General color blackish and greyish, irregularly mottled, varying in places according to the abundance of the white spicules and of the black pigment in the test and on the zoöids. *D. atrocanum.*

D.—Massive, partly opaque, consistency moderately firm, surface slightly rough ; apertures prominent. Spicules rather uniformly distributed, only moderately numerous. Color greyish, becoming black on parts of the upper surface. *D. porites.*

E.—Thin, incrusting, transparent, gelatinous. Surface smooth ; zoöids visible. Spicules in interior parts of the colony, not numerous enough to greatly diminish the transparency of the colony. Little or no dark pigment. *D. lucidum.*

F.—Thin, incrusting, translucent. Surface smooth, zoöids more or less concealed by the abundance of spicules, which are so distributed that the surface of the colony shows over the position of each zoöid a circular area, more transparent than the intervening spaces, which latter are white and more opaque, owing to the greater abundance of spicules there. Thorax of zoöids often dark colored. Colony whitish gray. *D. orbiculatum.*

Note.—The only specimens of species A and D which were found incrusted branching algæ, which no doubt influenced the form of the colony. Colonies growing on smooth surfaces will probably be found thinner and more expanded.

Didemnum solidum, n. sp.

PLATE LI. FIGURES 31 and 36. PLATE LIX. FIGURE 119.

But one specimen of this species was found. It is a very irregular colony, incrusting a growth of seaweed. In greatest length it measures about 45^{mm}, and reaches 4^{mm} or 5^{mm} in thickness in places. It is entirely opaque and of firm, almost brittle consistency, on account of the abundance of spicules, which are very evenly distributed in all parts of the colony. The surface is, for the same reason, slightly rough to the touch, and the apertures are conspicuous. Bladder-cells are scarce in most points of the colony.

The color is difficult to describe, being a reddish grey or buff, almost a flesh-color, darker above. It fades in preservation. The spicules are very uniform in size and shape, being about $.05^{mm}$ to $.07^{mm}$ in diameter, and have very short and stout, but regular and numerous conical points.

The zoöids are light colored and small, and placed rather far apart. They do not much exceed 1^{mm} in length in preservation, and are rather slender. There are probably not more than 12 stigmata in a row on each side.

None of those examined had well-developed reproductive organs.

The colony was obtained at Coney Island, May 16th, 1901, just below low water mark.

Didemnum savignii Herdman.

Didemnum savignii Herdman, Report Voy. Challenger, pt. xxxviii, p. 261.

PLATE LI. FIGURES 27 and 35. PLATE LIX. FIGURE 112.

The colony is incrusting but rather thick, and of rather soft, gelatinous consistency. The color is a rich brown, darker above, and the surface is smooth and glossy, the apertures inconspicuous and the spicules and zoöids invisible from the surface.

The largest specimen measures about 16^{mm} across, and is between 3^{mm} and 4^{mm} in greatest thickness.

The test contains great numbers of bladder cells, especially near the surfaces, where they are so abundant that they assume polygonal forms from mutual pressure. The dark color is due to brown pigment contained in the test cells. These pigment cells are most abundant near the upper surface, where they are irregular in form. In the deeper portions of the colony they are oval and less thickly distributed.

The spicules are very large, often .1^{mm} in diameter, with numerous long conical or somewhat flask-shaped points. They are chiefly confined to a layer lying about .5^{mm} to 1^{mm} below the upper surface. In this layer they are abundant and placed near together.

The zoöids are placed close together and mostly nearly perpendicular to the surface. They are rather large (the specimen figured (fig. 85) measured 1.6^{mm} long) and rather dark in color, due to brown pigment in the mantle, especially about the branchial aperture, and to a less extent on other parts of the thorax. The lining of the branchial siphon is particularly dark colored.

They have about sixteen stigmata in a row on each side. In several different individuals I found the number of turns in the spiral portion of the oviduct to be about eight. Herdman gives four or five as the number in his specimen.

The locality of the type of this species, described in the Challenger Report, is given as doubtful, but probably just south of the Cape of Good Hope, in 150 fathoms.

Only two specimens of this species were found at Bermuda, neither of them as large as the type specimen. One was obtained in 1898, the other in 1901, but the exact localities are not recorded.

Didemnum atrocanum, n. sp.

PLATE LI. FIGURES 80 and 84. PLATE LIX. FIGURE 114.

This species forms very thin incrusting colonies. The largest that were obtained measure 2^{mm} thick and from 30^{mm} to 40^{mm} across. In consistency it is gelatinous, and the spicules are not sufficiently abundant to greatly alter the character of the test.

The spicules are of moderately large size, averaging over .05^{mm} in diameter, but differ somewhat from those of *D. savignii* in having more numerous points, which are generally somewhat shorter and more or less irregularly rounded or split or broken at the extremities, though some have the regular conical or flask-shaped points, as in the last named species. They are irregularly distributed in the interior of the colonies, being thickly crowded in small patches and absent in other places. Where they are dense their white color makes them noticeable against the grey or blackish yet transparent test. Many bladder cells also occur.

The zoöids are not on an average quite as large as those of the last described species (*D. savignii*). In many of the specimens the mantle cells contain so much black pigment that the whole colony

appears quite blackish, for the zoöids are numerous and closely placed; in other cases they have but little dark pigment, and appear lighter than the greyish test, which also contains a greater or less number of black pigment cells.

I have found this form only at Hungry Bay, where it is common. A number of colonies were collected under stones in the latter part of May, 1901. None of the zoöids appear to have reproductive organs developed.

Didemnum porites, n. sp.

PLATE LI. FIGURE 29 and 33 PLATE LIX. FIGURE 115

A couple of colonies, the largest about 25^{mm} across and rather thick, were obtained growing on algæ in Bailey's Bay, May 1st, 1901. They differ considerably from *D. atrocanum*, though they are also of a grayish color, becoming black in the upper parts of the colony.

The test is of firm consistency, though bladder-cells are very abundant in some places; the spicules, which exactly resemble those of *D. lucidum* described below, are fairly evenly distributed through the test and come close to the surface, giving it a slightly rough granular character. The apertures of the zooids on the surface are conspicuous and slightly prominent. The test is opaque.

The zoöids are of good size (1.3^{mm} or 1.4^{mm} long in many cases in the preserved specimen), and have a little black pigment in the mantle walls. In structure they resemble those of *D. savignii*. I have counted ten or eleven turns of the vas deferens in some individuals.

Didemnum lucidum, n. sp.

PLATE LI. FIGURES 26, 28 and 37.

This is a species with very small zoöids (usually less than 1^{mm} in length), which are slightly or not at all pigmented, forming small, fairly transparent, nearly colorless incrusting colonies of slight thickness. Sometimes the anterior end of the zoöid is marked with a little blackish pigment about the aperture and over the ganglion.

The spicules, though varying much in size, are mostly under .04^{mm} or .05^{mm} in diameter. They have long but not very numerous conical points, and are distributed unevenly in the interior parts of the colony, generally not in sufficient abundance to greatly interfere with the transparency of the test. Near the surfaces of the colony they are wanting and there are a good many bladder-cells.

I have not been able to count more than about a dozen stigmata in a row on each side. None of the specimens have reproductive organs in good condition.

One colony of this little species was collected in 1898. In 1901 two or three were obtained in Bailey's Bay and Harrington Sound. One of the specimens grew on a branching alga, the others incrusted coral.

Didemnum orbiculatum, n sp

PLATE LI FIGURES 82 and 88 PLATE LXI. FIGURES 127*a* and 128

This is a form in many respects intermediate between a true *Didemnum* and a *Leptoclinum*, having the thin colony and abundant spicules characteristic of the latter, yet the large size of the spicules, their form, and the appearance and pigmentation of the zooids show it to be closely related to some of the species just described, and as I have been able to distinguish but three rows of stigmata it seems best to place it in this genus.

The largest specimens found were 25 or 30^{mm} across, and about 2^{mm} thick.

It may be recognized at a glance by the peculiarity in the distribution of the spicules alluded to in the analytical table above. The spicules, which are of fair size (about $.04^{mm}$), with rather slender conical points, are abundantly and thickly disposed in the test, yet not in such numbers as to give the colony the white, chalky appearance of a *Leptoclinum*, but leaving it a translucent grayish white. The zoöids are placed very close together, and there being but a thin layer of spicules over them, each branchial orifice appears in the center of a more transparent circular area of about the diameter of the thorax of the zoöid.

The zoöids are small (in contraction about 1^{mm} long). They have strong muscle bands in the mantle and contract badly in preservation. The mantle contains much dark pigment on the thorax, so that that part of the body often appears quite uniformly blackish.

This species is common and grows on the underside of stones near low water in company with colonies of *Leptoclinum*, *Diplosomoides* and *Botrylloides* at almost all suitable places along the shores of the islands. I found it especially common at Long Bird Island and at Waterloo, on Castle Harbor, in April and May, 1901. Many of the zoöids then contained large eggs, but I did not observe well developed testes in any of the numerous individuals examined.

Genus **Leptoclinum** Milne-Edwards, 1841.

Differs from *Didemnum* in having four rows of stigmata, and in forming a thin incrusting colony, densely crowded with calcareous spicules, so that the test becomes more or less hard and brittle.

Some species are said to have an atrial languet, but probably these should be placed in another genus.

In some cases the testis is deeply lobed, or it may be completely divided into two glands.

This genus is none too well distinguished from *Didemnum*, but is accepted by nearly all writers. The number of rows of stigmata (though apparently a reliable character in the Bermuda forms) is by no means always invariable, even in the same species, and in the character of the colony every gradation is found between the massive colony of a typical *Didemnum* and the thin, brittle crust of a typical *Leptoclinum*.

In this paper the writer has placed all the forms with three rows of stigmata in *Didemnum*, regardless of the thickness of the colony.

True *Leptoclinums*, with four rows of stigmata, occur in abundance at Bermuda, growing on corals, sponges and algæ on the reefs, and on the under side of stones along the shore, up to a point well above low-water mark. It is the most abundantly represented genus of ascidians there.

With only a limited number of specimens at hand, it is easy to classify them into several distinct and well marked species, differing from each other fully as much as some of the forms which are described above as species of the genus *Didemnum*, but with a large number of specimens available for study, the problem is by no means such an easy one, as so many intermediate forms occur. The writer devoted particular attention to collecting examples of this genus during his visit to Bermuda in 1901, but is obliged to confess, after examining a very large amount of material, that he has utterly failed to discover any character or characters by which the Bermuda *Leptoclinums* may be divided into groups worthy of specific rank. Apparently a process of active evolution is going on in the members of this group, at least in the Bermuda representatives of it, and from the hopeless confusion in which the species of this genus generally are involved, it seems not unlikely that this is the case elsewhere as well.

As the differences between the varieties are too great to disregard entirely, the only course open to the writer is to describe the most

striking variations as subspecies. Between these there are an indefinite number of intermediate forms. Nevertheless all these forms appear to have some degree of permanence, and reproduce their peculiarities at least in their immediate descendants, for often a number of colonies attached to the same stone, or growing near together, will have exactly identical characters, indicating a common parentage, while certain others, growing among them, will differ from them, yet agree among themselves.

The relation of these numerous varieties to previously described species of the genus is a difficult question. Naturally their nearest allies would be sought for on the Atlantic coast of the United States and in the West Indies. In neither of these regions has the genus been sufficiently studied.

Sluiter (15) has recently described two new forms, *L. conchyliatum* and *L. cineraceum*, from Jamacia, but these differ from the Bermuda forms, among other things, in the number of stigmata, for he says that they are provided with but from four to six stigmata in a row on each side, while the Bermuda forms have about 12 in those with large zoöids, and probably at least 8 or 10 in all cases.

From the Atlantic coast of North America two species only have been described, as far as the writer is aware; *L. albidum* Verrill and *L. luteolum* Verrill, the latter perhaps only a variety of the former. Both of these are found on the New England coast. The Bermuda varieties are quite different from the typical *albidum*, which has spicules of a different type from any of the Bermuda forms (fig. 41), and in most specimens the spicules are much larger than is the case in any of the latter.

Specimens of *L. luteolum*, from Southern New England, however, have spicules more like some of the Bermuda varieties (fig. 40). Yet the correspondence between *L. speciosum* Herdman (6), from Bahia, Brazil, and the commonest Bermuda form is so much closer that it seems best to consider the latter, and consequently the remaining Bermuda varieties, as subspecies of the Brazilian form.

The writer has not ascertained that any of the several varieties here described is confined to any particular locality at Bermuda.

Leptoclinum speciosum Herdman.

Leptoclinum speciosum Herdman, Report Voy. Challenger, pt. xxxviii, p. 274

The types are from Bahia, Brazil, in 7 to 20 fathoms. I have not found specimens at Bermuda which correspond exactly to the description of the Brazilian examples.

Var. **bermudense**, nov.

PLATE LII. FIGURES 39, 42 and 50. PLATE LXII. FIGURES 180c, 182 and 184.

Colony usually between 2 and 3^{mm} thick (when incrusting irregular objects often very much thicker) and reaching 60 or 70^{mm} in width in some cases. Spicules more abundant in the upper layers of the colony, though generally the extreme upper stratum is free from them, so that the surface is smooth to the touch. The spicules (figs. 39 and 42) are usually rather small (less than 0.025^{mm} in diameter) with a variable but generally very large number of points or rays. Occasional very large spicules occur among the small ones, but this is not peculiar to this variety. In some colonies most of the spicules have their points blunt and broken, in other colonies most of the points are perfect, but generally slightly rounded. As a rule the spicules are not so abundant as to render the test very stiff or brittle. The color is usually pure white, but it often becomes yellowish in preserved specimens. The apertures are generally not prominent.

The zoöids are large (up to 1.5^{mm} long, or more). Their tissues are yellow, the stomach and intestine being orange. They have 12 or more stigmata in a row on each side and 16 tentacles of two sizes. When the zoöids are very large, there are often additional, still smaller tentacles between the larger ones. The testis is generally single, but sometimes it is divided into two. The vas deferens makes about a dozen spiral turns.

This is the commonest form at Bermuda.

Var. **pageti**, nov

PLATE LII. FIGURE 45.

A dwarf variety of the last. The colonies are small (under 20^{mm} wide) and usually considerably under 2^{mm} thick. They have generally a distinct yellow tint, and the tissues of the zoöids are more strongly orange-tinted than in the last form, sometimes almost red, in which case the whole colony may have a salmon shade.

The zoöids are smaller and proportionately shorter than in var. *bermudense*. The spicules (fig. 45) are, however, similar. They have so many rays that unless highly magnified they appear almost spherical. Surface of colony rather smooth, apertures not conspicuous.

Often found associated with the last described form.

Var. **hamiltoni**, nov.

PLATE LII. FIGURES 43, 44 and 47. PLATE LXI. FIGURE 127*b*.
PLATE LXII. FIGURE 185.

In this the spicules are larger than in var. *bermudense* and they have coarser and less numerous but often rather longer points, and are more evenly distributed through the test, coming close to the upper surface. From this it follows that the colony is stiffer, harder and rougher than in the two last described forms. The zoöids are rather small (usually not much over 1^{mm} or 1.2^{mm} long) and placed near together. Their apertures are rather prominent on the surface. The colonies grow somewhat larger, but not very much thicker (generally about 2^{mm}) than those of var. *pageti*, into which it grades, and with which it is found associated. The colonies are very frequently decidedly yellow in color. It is a very common variety.

Var. **harringtonense**, nov.

PLATE LII. FIGURES 49 and 51.

This forms rather extensive (often 30 or 40^{mm} wide) colonies of moderate thickness (2^{mm} or over), white in color and resembling var. *bermudense*, but having much larger (up to 0.05^{mm}), longer pointed spicules. (Fig. 49.) They are abundantly placed throughout the test and make the colony hard and rough to the touch.

The zoöids are decidedly slenderer than in var. *bermudense*. They apparently have about 10 stigmata in a row on each side, short lobes to the branchial orifice, and but one testis. There are 16 tentacles or nearly that number. The vas deferens makes 8 or more turns (fig. 51).

Not common.

Var. **acutilobatum**, nov.

PLATE LII. FIGURES 46 and 52.

Resembles the last externally, but the colonies are rather thinner, and I have not observed such large ones. The spicules are small (0.025^{mm} in diameter), of remarkably uniform size and regularity of form, with very few points, which are conical with bulging sides (fig. 46). The zoöids are small and short (fig. 52), about 1^{mm} long in preservation, and are remarkable for the length and sharpness of the lobes of the branchial orifice. The testis is divided into two separate glands, each of which may be two-lobed. The vas deferens makes seven or eight turns.

Not common, but obtained both in 1898 and 1901.

Var. **somersi**, nov.

PLATE LII. FIGURE 48 PLATE LXII FIGURE 186.

Forms very small (10 to 20^{mm} wide), flat colonies of a pure white color. They are very thin (often under 1^{mm}) and not very opaque. The zooids are as small as those of var. *acutilobatum*. They are placed rather far apart. The spicules are large (fig. 48), with regular conical points of some length, and are evenly but often not very closely distributed in the colony. The positions of the zoöids are very conspicuous from the surface, though the apertures are not especially so. There is but one common cloacal aperture to the colony. The branchial apertures of the zoöids have pointed lobes but much shorter ones than those of the last described form.

Quite generally distributed, though not very abundant.

Genus **Polysyncraton** Nott, 1891

Separated from *Leptoclinum* (which it resembles in having four rows of stigmata) by having a number (sometimes as many as 10) of distinct pyriform testes, arranged in a circle, forming together a conical group, about which the vas deferens makes a few spiral turns: and by possessing an atrial languet.

The type of the genus is from New Zealand (13).

Polysyncraton amethysteum, n. sp.

PLATE LIV FIGURES 62 and 64 to 67 inclusive. PLATE LVIII. FIGURE 102.

Colony more or less transparent except for a thin layer of spicules on the upper surface. The test is of an amethyst purple or rose purple tint, due to pigment contained in the test cells, while the tissues of the zoöids are bright red. These colors fade out in preservation, the test becoming yellowish and the zoöids yellow or orange. The colonies seldom exceed 30^{mm} in width and 3 or 3.5^{mm} in thickness.

The layer of white spicules on the upper surface of the colony shows in strong contrast to the colors of the test. It may readily be stripped off. The spicules are entirely confined to it. Large areas about the common cloacal openings are entirely bare of spicules, also small oval areas about the branchial orifices, but in these latter may be seen small V-shaped groups of spicules, six in number in each, corresponding to the six lobes of the branchial siphons. This arrangement of the spicules about the branchial openings occurs

sometimes in other genera of this family (*Leptoclinum*, *Didemnum*), but is especially conspicuous here. (Fig. 65.)

The spicules are always small with short and often more or less blunt and broken points. In some colonies they are all very minute, in other specimens they vary more in size (compare fig. 64 with fig. 67 both down to the same scale). The test contains vast numbers of bladder cells.

The zoöids also vary much in size in different colonies, reaching 1.5^{mm} or more in length in many cases. There are six short lobes to the branchial siphon, and a rather long, somewhat forked languet over the atrial orifice. There are four rows of stigmata with a moderate number in each, and probably eight tentacles.

The male reproductive organs consist of about five (the number varies) separate pyriform testes placed radially with the small ends in the center, where the short ducts arising from them unite to form the vas deferens which coils about the group in the usual manner, making about five turns. The ovary lies between two of the testes on the side toward the stomach, more or less covered by or included in the coils of the vas deferens, except when the eggs become so large that it must extend beyond these limits.

This beautiful species is moderately common, both along the shore under stones, and in deeper water on corals, sponges, etc. It was obtained in Castle Harbor; Harrington Sound; and at Hungry Bay; and was collected both in 1898 and 1901. The specimens contain large reproductive organs and larvæ, and the species would probably be an unusually favorable object for embryological or histological investigation.

Genus **Diplosoma** MacDonald, 1858.

Colony incrusting, generally rather thin. The test is penetrated by more or less extensive cavities continuous with, and regarded as extensions of, the common cloacal cavities, which greatly reduce the amount of test substance, leaving in extreme cases little of it except the thin layer bounding the colony and a thin layer about each zoöid, the latter being retained in position by strands or columns of test substance continuous with the layer bounding the colony. All the rest of the interior of the colony becomes one large cavity. The extent to which this modification proceeds varies in different species and to a considerable degree in different individuals.

The test substance is gelatinous, becoming membranous on the surface, and from its nature, as well as from the extensive cavities

above mentioned, the colony is very soft and delicate. No spicules are present. The test is often very transparent.

The zooids have six lobed, or nearly simple branchial apertures, and simple atrial openings

The branchial sac has four rows of rather large stigmata. The transverse vessels are muscular, and as in *Leptoclinum* there is a muscle band along each side of the dorsal lamina. The bands unite at the posterior end of the thorax, and are prolonged into a muscular and vascular process extending posteriorly and ventrally into the common test. It ends bluntly and is much weaker and less conspicuous than in *Leptoclinum*. I have found it in all the species of this genus described in this paper.

The intestinal loop is twisted and generally bent so that its axis lies about at right angles to that of the thorax. This brings the reproductive organs, which lie on the left side of the abdomen, under the intestinal loop. The stomach is oval and smooth-walled, on the outside at least.

There are two testes placed close together, forming as in *Leptoclinum* a conical mass, but the vas deferens does not coil about them.

With the related *Diplosomoides* Herdman, which has small stellate calcareous spicules, this genus is often made a separate family, the Diplosomidæ.

Diplosoma macdonaldi Herdman

Diplosoma macdonaldi Herdman, Report Voy Challenger, pt xxxviii, p 815.

PLATE LIII. FIGURE 60 PLATE LX FIGURE 124

Colony large (50^{mm} across) and rather thin, not exceeding 2 or 2.25^{mm} in thickness. Test nearly colorless and very transparent, membranous on the surface. The cavities characteristic of the genus are well developed, yet there is considerable test substance about the zoöids which adheres very firmly to their mantles and contains here and there a few bladder cells. In addition to the small test cells, there are large oval or slightly irregular cells which stain deeply with plasma stains.

The zoöids are also nearly colorless except that the stomach and more or less of the intestinal loop is yellow or orange. This fades out in preserved specimens. The zoöids are large for this family, sometimes reaching 1.6^{mm} in length when straightened out and expanded. The mantle muscles are but slightly developed and are mostly transverse.

There are four rows of stigmata, with about a dozen in a row on each side. The stigmata are large with very narrow interstigmatic vessels. The transverse vessels are fairly muscular and contract strongly in preserved specimens, as the rest of the branchial sac is very delicate.

The endostyle is rather narrow. The dorsal languets are long enough to extend more than half way across the branchial sac. They are tentacular in form. The tentacles appear to be about twelve in number, and are of two sizes placed alternately.

This species was described by Herdman from a specimen found in shallow water at Bahia, Brazil.

The large colony here described, which I identify with the Brazilian form, was obtained in April, 1901, in Harrington Sound, on a piece of coral. Another smaller colony was obtained off Bailey's Bay a few days later. It was attached to a sponge, and differs in having somewhat smaller zoöids, but there seems to be little doubt that both are of the same species. Some of the zoöids contain well developed testes and small eggs, but none of those examined contained large eggs. Nearly all the zoöids in each specimen have buds.

Diplosoma lacteum, n. sp.

Plate LIII. Figure 59.

This species forms small, somewhat flattened colonies measuring 10 to 15^{mm} across and 3 to 4^{mm} in thickness when alive. The cavities in the test are enormously developed and only a very thin layer of test surrounds each zoöid, while the layer bounding the colony is also very thin, so that preserved specimens are generally collapsed, and present a very different appearance from living ones. This is further increased by the fact that in life the test is opaque and of a milky white color which disappears in preservation, leaving the test colorless and transparent.

There is a little blackish pigment on the zoöids, contained in the mantle of the abdomen. The cells constituting the epithelium covering that part of the body are large and flattened, and contain the dark pigment chiefly near the edges, the center being clear and occupied by the nucleus, so that each cell appears as a small dark colored polygon with a clear center.

The zoöids measure at least one-third less than those of the last described species, but do not differ in structure as far as I have observed, except that there appear to be fewer stigmata in a row.

The writer collected a number of small colonies of this form under stones near low-water mark at Hungry Bay, May 21st, 1901. One or two specimens were also found in similar situations at Waterloo, on Castle Harbor, about the same date. None of the specimens examined contained large eggs, though in some the testes were well developed.

Diplosoma atropunctatum, n. sp

PLATE LIII FIGURE 56. PLATE LVIII. FIGURE 108
PLATE LXII. FIGURE 137

This species is closely related to *D. lacteum*, and the writer describes it with some reluctance, as he has but a single specimen. This is a colony about 25^{mm} across, which was found growing on a coral (*Porites*) in Harrington Sound, April 30th, 1901, in water about twelve feet deep. The test, both in the living and preserved condition, is perfectly colorless and transparent, allowing the small zoöids, which are but little larger than those of *D. lacteum*, to be seen with the greatest distinctness. This is in strong contrast to the milky white opaque test of living specimens of the last mentioned species. The test cavities are also less developed, leaving more test substance than is usual in *D. lacteum*.

The whole abdomen of the zoöid is deeply colored with blackish or dark greenish pigment, contained in the mantle cells as described in the last species, and as the thorax is colorless, the abdomens of the zoöids are conspicuous as small black dots, and the colony might easily be mistaken for a mass of eggs of some mollusk.

I found no noticeable differences in the structure of the zoöids by which they could be distinguished from those of *D. lacteum*. Many contained both large eggs and large testes.

Genus **Diplosomoides** Herdman, 1886.

Differs from *Diplosoma* only in having stellate calcareous spicules in the test.

Diplosomoides fragile n. sp.

PLATE LIII. FIGURES 57 and 58. PLATE LXI. FIGURE 126.

In appearance, this species resembles a *Leptoclinum*, as it forms very thin, flat, expanded colonies often 60^{mm} or 80^{mm} across, of a very pure white color, which is produced by the abundance of minute spicules. These are generally not much over .02^{mm} in diame-

ter, and have very short, but often very slender and numerous points, which are usually more or less rounded or broken at the ends, though they may be needle-like. The points are so numerous and short that the spicule appears practically spherical when not much magnified. They greatly resemble those of some forms of the genus *Leptoclinum.* In life, the colony is of a purer white color than most of the species of *Leptoclinum* found at Bermuda, but preserved specimens turn slightly yellowish.

This species may at once be distinguished from the other members of the family with which it is found associated by the great delicacy of its structure It breaks or tears at the slightest touch, and is difficult to remove whole from the object on which it grows. This is due to the extensive development of the cavities of the test as already described in *Diplosoma* The test is reduced to an upper and lower layer forming the two surfaces of the colony, and a small mass surrounding each zooid, and the fact that it is in all parts quite densely crowded with the spicules renders the thin layers of test substance very brittle.

The zooids are large (1 5^{mm} long) and also of very delicate structure. Their apertures are always distinctly visible on the surface of the colony. Their tissues are yellow or orange in color

The musculature, both of the mantle and of the branchial sac, is very weak. The muscle bands along the dorsal lamina are distinguishable, but the muscular process is rudimentary, if indeed it is developed at all, and the transverse vessels of the branchial sac are not perceptibly muscular. All the vessels of the branchial sac are very slender. There are about a dozen large stigmata in a row on each side. The tentacles are slender and of at least two sizes; I have not determined the number.

The stomach wall is exceedingly thin and often becomes folded, but this is probably not its natural condition.

The reproductive organs resemble those of *Diplosoma.*

This is a very common species, occurring under stones near low-water mark at various points about the islands. I found it particularly abundant at Waterloo, on Castle Harbor, also at Long Bird Island and Coney Island.

Genus **Echinoclinum**, n. gen.

Test gelatinous, becoming tough and membranous on the surface and about the zoöids. The latter are surrounded by a more or less complete calcareous capsule composed of the test spicules.

These spicules are tetrahedral in form, with each angle prolonged into a pointed ray or spine, and usually so placed about the zoöid that one point is directed radially outward. A few are also scattered about in other parts of the test.

Zoöids with rather large branchial sacs with four rows of stigmata. Branchial aperture six-lobed, atrial plain.

Echinoclinum verrilli, n. sp

PLATE L. FIGURES 23, 24 and 25

The largest colony of this species which was obtained measured about 12^{mm} across and about 3^{mm} in thickness. The zoöids are arranged in branching systems.

The test is colorless and very transparent in the preserved specimens. I have no notes upon its appearance in life. Though soft and flexible, it is continuous and solid, and no such extensive cavities occur as is usual in *Diplosoma* On the surface and immediately around the zooids, where, as already mentioned, most of the spicules are situated, the test is very tough and membranous. Elsewhere it is soft and gelatinous, and contains only a few scattered spicules, and here and there a few bladder cells.

I have not been able to distinguish any muscular processes extending out from the zoöids into the test, but it is almost impossible to remove the zoöids from the above mentioned tough membranous layer of test which surrounds them. It adheres to the mantle very closely at several points. One of these is about the atrial aperture. In addition there are two small areas, one on each side of the posterior part of the thorax, where the mantle and test are very firmly united, but I have made out no vascular processes extending out at these points. Sections of the thorax show that in these places there is a concavity in the contour of the body wall, and a corresponding projection of the common test into it, this being the part which adheres to the mantle.

The spicules vary much in size, the largest measuring about $.15^{mm}$ across from point to point. On each side of the thorax of the zoöids, these are small groups containing smaller spicules than those found elsewhere. Apparently these are at the points above mentioned where the mantle and test adhere together. In addition to the spicules, the test contains some large, round, yellowish green cells, which are probably symbiotic algæ, as well as the usual small test cells.

The zoöids are small (less than 1^{mm} in length in the contracted

state), and pale yellowish in color. The mantle is not noticeably muscular, but there are strong muscles on the transverse vessels of the branchial sac and along each side of the dorsal lamina.

There are four rows of a dozen or more rather long stigmata and apparently about a dozen tentacles. Between the thorax and abdomen the body is constricted into a narrow but rather short peduncle. The mantle is somewhat produced just anterior to the atrial orifice, but hardly sufficiently to be termed a languet. The branchial siphon is short and has six small lobes.

The intestine forms a rather small twisted loop, and the stomach is rounded and smooth-walled externally, though slightly ridged on the inner surface in a longitudinal direction.

Though I have examined a great number of the zoöids, I have not found any with sexual organs developed, but many of them have small buds in the region of the peduncle.

Three small colonies were found in 1898, one of which was growing on a specimen of *Clavelina oblonga;* the other two on a branching alga. None were collected in 1901. I do not know the exact locality where the specimens were obtained.

Family BOTRYLLIDÆ Verrill, 1871

Colony thin and expanded or thick and fleshy. Zooids always arranged in systems. Test gelatinous, traversed by branching vessels with enlarged terminal bulbs, which are especially numerous near the margins of the colony.

Zoöids short-bodied, not divided into thorax and abdomen.

Branchial sac large, with numerous stigmata and with several internal longitudinal bars on each side, but no folds. Dorsal lamina a plain membrane. Tentacles usually few

Loop of alimentary canal placed alongside the posterior portion of the branchial sac. Stomach-wall folded longitudinally. A large gastric cæcum is present.

Reproductive organs (both ovaries and testes) developed on both sides of the body. Budding from wall of peribranchial cavity.

Sympleyma Herdman presents exceptions to this diagnosis.

Genus Botrylloides Milne-Edwards, 1842.

Distinguished from *Botryllus* by having the zoöids arranged in extended branching systems instead of small round or oval ones, and from *Sarcobotrylloides* von Drasche by forming thin instead of thick fleshy colonies.

The form of the systems is not a very satisfactory character on which to base a group of full generic rank, and various writers have attempted to attribute to *Botrylloides* additional distinguishing characters based on the cylindrical form and upright position of the zooids in the colony, as well as on the position of the atrial siphon, which in this genus is said to be placed near the anterior end, while in *Botryllus* the zooids are of more ovate form, lie horizontally in the colony and have their apertures more widely separated.

These characters are of very little significance. The form and position of the zoöids is chiefly dependent on the closeness with which they are crowded together in the colony, while the position, form, and length of the atrial siphon depend entirely on the relation of the zoöids to the common cloaca, or the branch of the same into which the zoöid discharges, and to which, of course, the atrial siphon must reach. Great variations in these characters may occur within the limits of a single colony, and they are not even of specific value. The genus must be separated from *Botryllus*, if separated at all, on the strength of its complex branching systems.

As with the Botryllidae of other parts of the world, the Bermuda forms are very variable, both in color and shape, and in the arrangement of the zoöids in the colony, and it is difficult to determine how many distinct species are really represented. The differences between the extremes of variation are ample for regarding them as distinct species. Yet so many colonies with characters intermediate between those of the types described below are to be met with in a large series of specimens, that the writer does not feel justified in giving the new forms which are here described full specific rank, and in this paper all the Bermuda forms, distinct from each other as the typical examples are, will be treated as subspecies of *B. nigrum* Herdman.

Botrylloides nigrum Herdman.

Botrylloides nigrum Herdman, Report Voy. Challenger, pt. xxxviii, p. 50.
Botrylloides nigrum Herdman, Sluiter, Tunicaten von Süd-Afrika, Zoöl., Jahrbücher, vol 11, 1897.

PLATE LIII. FIGURE 54. PLATE LXI. FIGURE 125.

To this species, described by Herdman from specimens taken "near the island of Bermuda," most of the examples obtained can be referred without much question. It is a common species and was found both in 1898 and 1901, and also by Prof. Goode in 1876.

It forms flat, incrusting colonies, 2 or 2.5^{mm} in thickness, and sometimes 70^{mm} across. There is great variation in respect to the closeness with which the zoöids are arranged in the colony in different specimens. Where they are placed close together the zoöids are nearly cylindrical and have a nearly upright position ; where they are less crowded, they lie more obliquely, with the anterior end turned up, so that the body is curved. There is also great variation in the number and conspicuousness of the test-vessels and their bulbs, and in some colonies the young zooids, or buds, appear between the rows of adults arranged with nearly as great regularity as the adults themselves, but often quite differently colored.

In addition to these variations the color varieties are almost innumerable. Not much weight can be placed on such differences in the case of this family. They do not constitute true varieties, but are mere individual peculiarities. The work of Pizon (14) on certain species of *Botryllus* emphasizes this fact and shows that the colors of the same individual may change from time to time.

In the majority of specimens the zoöids are colored some shade of purple, purplish brown, or purplish red ; sometimes so dark as to be almost black ; at other times very pale and light colored. When the zoöids are deeply tinted the test is usually dark colored and pervaded with more or less of the same tint which predominates in the zoöids, so that it loses a good deal of its transparency. In light colored specimens it is often nearly colorless, allowing every detail of the external anatomy of the zoöids and the test vessels to be seen with great clearness.

The purple pigment which gives the zoöids their color is in part diffused through the tissues, but is chiefly contained in cells which occur most abundantly in the mantle near the anterior ends of the zoöids. They are also present in other parts of the zoöids, especially along the transverse vessels of the branchial sac, and on the walls of the end bulbs of the test-vessels. The purple pigment is also contained in many of the blood corpuscles, and in the cells contained in the bulbs of the test-vessels. The extent of its distribution is very variable.

In some cases this purple pigment is replaced by a light bluish grey pigment, but in preserved specimens this changes to purple.

In addition to this ground color the zoöids are usually, though not always, marked with a light colored pigment. It is usually a peculiar and very pure white, which is contained in opaque oval cells of the same size as those containing the ground color. They either

cover the anterior end of the zoöids about the branchial orifice (often obscuring the ground color) or form a ring about it, or in other cases a star-shaped area with about eight rays. Frequently they are scattered over the mantle in small groups, on the bulbs of the test-vessels, and often elsewhere. The white may be replaced by pale greenish, light yellow or (in one specimen) even bright orange. This light colored pigment disappears completely when the animal dies, and the zoöids become some shade of purple, purple-red, or blackish, and the test loses most of the color it possessed during life (even where it was quite dark colored) and becomes much more transparent.

Space will not permit of more particular description of the various colors assumed by different specimens, all of which I consider no more than individual variations of one and the same species. It is, in many of its forms, among the most beautiful and brilliantly colored of compound ascidians, and the name *nigrum* is by no means appropriate, though black colonies do occasionally occur. Herdman wrote his description from alcoholic specimens, which are often black or nearly so.

There are nearly always small groups of very large round cells with purple or purplish red pigment on the mantle along each side of the endostyle. What their nature or function is I am unable to say. Such cells occur also in the varieties *concolor* and *planum*, described below.

The zooids in this species are rather small. In the contracted state in which they occur in preserved specimens they do not average over 1.5^{mm} in length.

The mantle is (for this genus) fairly muscular and the zoöids in the contracted state are apt to assume the curved cylindrical form which is well shown in fig. 54 and is rather characteristic of the species. The mantle muscles consist of delicate fibers and are chiefly developed in the dorsal region. The transverse vessels of the branchial sac also have muscle fibers.

There are about thirteen rows of stigmata and three internal longitudinal bars on each side. Between each of these there are about three stigmata, but on each side of the dorsal lamina and endostyle there are four or five. The tentacles are eight in number, larger and smaller alternating. The atrial siphon is very large and forms a capacious chamber with a large funnel-shaped opening, the anterior lip of which is prolonged into a languet. The position, form and length of the siphon varies according to the relation of the zoöid to

the common cloacal chamber into which it discharges. It is usually back a considerable distance from the anterior end.

The stomach has about eight or ten longitudinal folds and a large cæcum on the side toward the intestine. With this the duct from the glandular organ about the intestine communicates. The tubes of this organ have large dilated extremities.

The male reproductive organs consist of a large many-lobed testis on each side, near the posterior end of the branchial sac; just anterior to them the ovaries are located. In many colonies none of the zoöids appear to have reproductive organs. Fig. 54 was drawn from such a specimen.

This form is very widely distributed at Bermuda, occurring attached to the under side of stones near low water mark, and in deeper water on the lower parts of corals and gorgonians. One of the specimens obtained by Goode was growing on eel grass as is the common habit of *Botryllus gouldii* Verrill of the New England coast. Sluiter records this species from South Africa.

The internal structure of the zoöids in the two following forms does not appear to differ from that of the typical *B. nigrum*.

Var. **planum**, nov.

PLATE LIII. FIGURE 55. PLATE LIX. FIGURE 110.

The type specimen was obtained by Professor Verrill in 1898. It covers a number of square centimeters of the surface of a piece of limestone. In the preserved specimen the zoöids appear of a dark purplish color. Some of the mantle cells are especially rich in pigment, giving the zoöids a speckled appearance under the microscope. The peculiarity of the specimen is the greatly flattened and expanded condition of the colony, the zoöids lying on their ventral surfaces, well separated from each other, though arranged in the characteristic elongated systems of a *Botrylloides*.

The zoöids themselves are much flattened and the anterior end is sharply turned up. The mantle is nearly devoid of muscle fibers; it is much larger than the branchial sac, and the atrial siphon opens far back toward the posterior end.

Another specimen, incrusting a piece of coral, was obtained by Prof. Verrill, in 1901, in Harrington Sound. The zoöids are purple in color, but lack the deeply pigmented cells in the mantle. In both colonies the test-substance is transparent and nearly colorless, forming a very thin expanded layer over the object on which the colony grows. I have no notes on their colors during life.

Var. concolor, nov.

PLATE LIII. FIGURE 58.

The colony in this variety resembles that of the typical *B. nigrum* in form, though I have not seen specimens measuring more than 30 or 40^{mm} across. The zoöids are slightly larger, and the mantle-musculature appears to be generally weaker, so that in preserved specimens the zoöids are not generally found contracted into the compact cylindrical shape which, as already remarked, is rather characteristic of *B. nigrum.*

In life the color is a brilliant orange; the zoöids, and to some extent the test as well, having this color. It mimics quite closely the color of a species of sponge very abundant in the same situations. In specimens preserved in formalin the orange changes to a brown, red-brown, or even purplish.

Examples were collected in Harrington Sound, Castle Harbor, and at Somerset Id. It appears to be commoner on the reefs, attached to algæ, corals and gorgonians, than it is near low-water mark.

Var sarcinum, nov.

Differs from the typical *B. nigrum* in forming a thick, fleshy colony of gelatinous consistency, with thick rounded edges. The type specimen measures about 50^{mm} across and is from 4 to 8^{mm} or more in thickness. The zoöids (purple in color in the preserved specimen) exactly resemble those of a typical *B. nigrum.* The gelatinous test is yellowish with a purplish tinge. It was obtained by Prof. Verrill in 1898.

There are other specimens in the collection which show characters more or less intermediate between this form and the true *nigrum.*

This variety forms a sufficiently thick and massive colony to be placed in the genus *Sarcobotrylloides* von Drasche, which is distinguished from *Botrylloides* only by the thickness of the colony. The writer is inclined to question the necessity of recognizing *Sarcobotrylloides,* even as a subgenus.

Genus **Symplegma** Herdman, 1886.

Symplegma viride Herdman.

Symplegma viride Herdman, Report Voy. Challenger, pt. xxxviii, p. 144, pl. xviii, figs. 7–14.

PLATE L. FIGURE 22.

Herdman described under this name a specimen, taken by the Challenger expedition "in shallow water near Bermuda," forming for it a new genus and placing it, though with some doubt, in the

Distomidæ. Lahille considered that it should be placed in the Botryllidæ, and Herdman in his later work has followed him in this. Only a single colony was obtained, and that, as Herdman says, was in poor condition. As far as the writer is aware, the species has not been found since, though through an oversight it was included in Prof. Verrill's (17) statement of the species found in 1898.

The following details are from Herdman's description:

The colony consists of heads connected by branching peduncles. The heads are narrow at the lower end and taper gradually into the peduncles. "The color of the head is a dull green with spots of reddish brown scattered here and there. The peduncle is of a dull greyish yellow color." (These no doubt were the colors of the preserved specimen.) Length of head of average size 12^{mm}, greatest thickness 7^{mm}, length of peduncle about 15^{mm}, thickness 3^{mm}.

The test is tough and firm. Muscle bands of the mantle not large, but numerous and running in all directions. The sphincters of the siphons are especially strong.

The branchial sac is large, with numerous stigmata, and provided with internal longitudinal bars. The dorsal lamina is a plain membrane and there are eight tentacles, all of one size.

The body of the zoöid is not divided into thorax and abdomen. The alimentary and reproductive organs form a mass projecting a short distance beyond the branchial sac. The stomach is folded longitudinally and provided with a cæcum.

There are branching vessels in the test, with enlarged terminal bulbs containing corpuscles.

Family **POLYSTYELIDÆ** Herdman, 1886. (**Polyzoidæ** Michaelsen, 1900.)

Colony variable in form, but always without systems, the atrial as well as the branchial aperture of each zoöid opening independently on its surface. Test penetrated by branching vessels with enlarged terminal bulbs.

Zoöids with both apertures four-lobed, if lobes are developed. Branchial sac with many rows of stigmata, with internal longitudinal bars, and often with folds. Dorsal lamina a plain membrane.

Alimentary loop usually lying alongside the branchial sac. Stomach-wall longitudinally folded.

Reproductive organs in the form of polycarps containing either testes or ovaries, or both, attached to the inner wall of the mantle in the peribranchial cavity. They are developed on both sides of the body.

Method of budding pallial (from wall of peribranchial cavity).

The most important work dealing with the classification of the members of this family is that of Michaelsen (12), previous classifications being based upon the form of the colony or other features of little significance.

Michaelsen makes the structure of the reproductive organs the chief character in distinguishing the genera. There is no doubt that this is a great advance toward a natural system, and although his innovations in the nomenclature may not be accepted in every instance, he is amply justified in rejecting many of the older and imperfectly characterized genera.

I have not, however, been able to include either of the two Bermuda forms, here described, in any of Michaelsen's genera. Even if only the structure of the reproductive organs be considered, his definitions would have to be modified (though in one case only slightly) in order to receive them, and I believe that other differences in the anatomy are of sufficient weight to justify the formation of new genera.

Michaelsenia, n gen

Colony incrusting. Test thick and leathery. Both apertures four-lobed.

Branchial sac with folds and many internal longitudinal bars.

Reproductive organs consist of a number of hermaphrodite polycarps of rounded or oval form, arranged in two rows (one each side of the endostyle) on the ventral surface of the body, from which they project into the test as papillæ or tubercles, invested by an evagination of the mantle, to the inner surface of which they are attached.

The form for which I have established this genus differs from the genus *Styela* of the Simple Ascidians in only two essential characters: first, in producing buds and forming colonies; second, in the above described arrangement of the sexual organs. In the character and appearance of the test, apertures, tentacles, and branchial sac, as well as in many minor particulars, the resemblance to *Styela* is very striking.

It is most closely related to Michaelsen's genus *Polyzoa* Lesson as far as the structure of the reproductive organs is concerned, though there the testis consists of but one vesicle in each polycarp. In that genus, moreover, the branchial sac is without folds and has but eight internal longitudinal bars on each side, and the form of the colony is very different.

Michaelsenia tincta, n. sp.

PLATE LIV. FIGURES 61 and 63. PLATE LIX. FIGURE 109

The examples found contain only a few zoöids, from two or three to a dozen, and do not often measure more than 15^{mm} across or 3.5^{mm} in thickness at any point. The surface is finely wrinkled and uneven, often raised over the positions of the zooids, and the edges of the colony are thin and produced some distance beyond the zoöids. It is practically free from all incrusting matter. The test-substance is tough and leathery, and opaque, except that about the edges of the colony, or in other places where it is thin and slightly pigmented, it is more or less translucent. The zoöids and the test vessels (which have elongated club-shaped bulbs) can usually not be distinguished through it, and in many specimens the number and location of the former can only be seen by the slightly projecting apertures, which do not show their square or four-lobed shape when they are contracted, unless the zoöid is removed from the test.

The color is a rather dull carmine-red, deeper about the apertures and paler near the edges and in the lower parts of the colony. Where the pigment is scarce, the test becomes yellowish. When sectioned and stained the test is seen to have a fine fibrillar structure.

The largest zoöids measure from 5 to 6^{mm} in length and 2 to 2.4^{mm} across. They lie on the ventral surface, with the anterior end turned more or less abruptly upward, bringing the branchial orifice a little way back from the end, and are much flattened dorso-ventrally. The atrial orifice, which like the branchial is situated at the summit of a low conical projection, is placed at a varying distance from the posterior end.

The mantle, especially the dorsal part, is colored a bright carmine by pigment grains contained in its cells. These grains are situated near the periphery of the cells, the central part remaining clear. The mantle-muscles are weak and not gathered into bands.

There are a great many slender tentacles of two or three sizes, none of them very long.

The branchial sac has three or four distinct folds on each side. On each fold there are about three internal longitudinal bars, and usually one on each intervening space. The internal longitudinal bars are thus situated at unequal distances apart, there being some six or eight stigmata between them in some places and only about two on the folds. The large transverse vessels number about fifteen, but between each pair there is usually a more slender intermediate vessel. The stigmata (which are narrow) often run past

this intermediate vessel from one large vessel to the next. In other places the stigmata are interrupted by the intermediate vessel

The stomach is long and narrow, deep yellow or brown in color, with many longitudinal folds and a small cœcum on the side toward the intestine. There are a considerable number of short atrial tentacles.

There are a number of polycarps arranged along each side of the ventral part of the body. They are hermaphrodite, containing two large pyriform or oval testes and a number of ova Often, as sections of the colonies clearly show, they lie in small papillæ or knob-like evaginations of the body-wall which are thus more or less nearly surrounded by the test, and may communicate with the body only by a somewhat constricted neck. It is probably on account of these, as well as because of the large and strong vascular processes arising from the posterior ventral part of the body, that it is very difficult to remove the zooids from the test entire.

Specimens of this species preserved in formalin retain their natural color for a considerable time. In its character and appearance a colony closely resembles a flattened example of some of the simple ascidians of the family Cynthiidæ, with which it is found associated, though the numerous apertures serve to distinguish it. The colony looks more like an aggregation of small simple ascidians than a compound ascidian.

This species is found on the under side of stones near low water mark, nowhere in great abundance, but widely distributed, and it was collected in 1901 at nearly all the points about the islands where much collecting was done.

Diandrocarpa, n gen.

Colony incrusting. Apertures elliptical, without lobes. Tentacles few.

Branchial sac simple ; no folds and few internal longitudinal bars. No small intermediate transverse vessels.

Loop of alimentary canal large, placed beside the branchial sac.

Reproductive organs consist of a single mass on each side of the body, each with two large pyriform or lobed testes and a group of eggs.

I form this genus for the species described below, which differs too much from the type of *Gynandrocarpa* Michaelsen to be placed in the same genus with it. (The type of Michaelsen's genus is

Goodsiria placenta Herdman, which forms pedunculated colonies and has a folded branchial sac with numerous longitudinal bars.)

Synstyela monocarpa Sluiter, from South Africa, which is included by Michaelsen in *Gynandrocarpa*, is however closely related to the form here described, and is better placed in this new genus than in *Gynandrocarpa*, and I have so defined the genus that it may be included. Possibly one or two other species might also find their place here. *Synstyela* Giard is rightly rejected by Michaelsen as too poorly defined to be certainly recognized.

Diandrocarpa botryllopsis, n. sp.

PLATE LIV. FIGURE 68. PLATE LIX. FIGURES 120 and 121.
PLATE LX. FIGURE 123.

The colonies are very thin, seldom averaging over 2^{mm} thick, though the surface is slightly raised over the position of each zoöid. In outline they are very irregular, but sometimes measure 60^{mm} or more in the longest direction. Frequently they break up into a number of small colonies, which may remain slightly connected.

The test is very soft and gelatinous with a slightly tougher outer layer. It is transparent and almost colorless after death, but in the living and expanded animal it has more or less of the dark color of the zoöids. The reason for this is not clear, but it may be due in part to greater distension of the test vessels with colored corpuscles in the living animal. These vessels are quite numerous, especially in the marginal parts of the colony, and have club-shaped terminal bulbs, but the latter are not proportionately very large.

The zoöids reach about 2.5^{mm} in length and 1.3^{mm} in width, or slightly larger when fully expanded. They lie on their ventral surfaces, and have the branchial aperture close to the anterior end and the atrial near the middle of the body. The apertures project but little and are elliptical, with the long diameter parallel to the long axis of the body, and without lobes, but sometimes with minutely denticulate edges.

Their color (due chiefly to corpuscles contained in their vessels and in the mantle) is blackish, or some shade of dark purplish brown or brown, sometimes even dark olive. During life the branchial aperture is surrounded by an area of white pigment, or sometimes greenish white, pale salmon, or pale yellow. This has an irregularly stellate outline, and there is also considerable of the light pigment over the region of the ganglion and in small dots at various points on the mantle and on the bulbs of the test-vessels. This pigment

mostly disappears when the animal dies, and the dark pigment of the test and vessels usually becomes lighter and of a more purple tint: The whole coloration is strongly suggestive of the family Botryllidæ.

The zoöids taper toward the anterior end, and have the posterior end broad and rounded. They are more or less flattened in a dorso-ventral direction, or somewhat obliquely. The musculature of the mantle is chiefly transverse, but weak and inconspicuous. The tentacles are few in number and are probably of two sizes, placed alternately.

The branchial sac extends practically the whole length of the body and conforms to its shape. The dorsal lamina is a plain membrane. There are four, possibly five, internal longitudinal bars on each side, and four or five stigmata in the meshes of the network thus formed The transverse vessels appear to be of one size only, but the branchial sac is somewhat irregular and the transverse vessels of the two sides do not meet the dorsal lamina exactly opposite each other. There are about 13 or 14 rows of stigmata.

The stomach and intestine lie on the left side of the branchial sac. The short, curved œsophagus extends ventrally and to the left, and opens into the stomach, which is grooved or folded longitudinally with about ten folds, and lies with its axis directed obliquely forward and somewhat ventrally. The cardiac end is the smaller. From the stomach the intestine, which is in this region of large diameter, proceeds forward and dorsally, then posteriorly and finally bends abruptly forward to form the rectum, which is of smaller diameter. The glandular tubes which surround the intestine have large dilated ends. I have not been able to determine that any atrial tentacles are present. The reproductive glands are generally further forward on the left side than on the right. On each side there are two large pyriform testes placed one behind the other, with their small ends together, and the ovary, which was small in all the specimens examined, was situated between or close against the testes.

The test vessels arise from the posterior part of the ventral side of the zoöid.

This is a moderately common species, and was collected in several places, especially, however, at Coney Island, and Waterloo on Castle Harbor. It was obtained both in 1898 and 1901, as well as by Prof. Goode in 1876–77, and generally grows on the under side of stones or other solid objects near or below low-water mark.

ASCIDIÆ SIMPLICES.

Fixed (rarely unattached and never free swimming) ascidians which do not reproduce by budding or form colonies.

The branchial sac is enormously developed, occupying the greater portion of the body and is provided with a very large number of stigmata.

The viscera lie alongside the branchial sac, though they may project behind it to a very slight extent.

This group is usually considered a sub-order.

Family **HALOCYNTHIIDÆ** (**Cynthiidæ** Lac. Duth., 1877.)

Body usually attached, sometimes stalked.

Test membranous, coriaceous, or sometimes cartilaginous, sometimes incrusted with sand or other substances. Branchial and atrial apertures usually four-lobed.

Branchial sac longitudinally folded, with internal longitudinal bars, which do not bear papillæ.

Tentacles simple or compound.

Intestine on left side.

Reproductive organs attached to the inner surface of the mantle, on one or both sides of the body.

The name of the principal genus of this family was changed by Verrill to *Halocynthia*, as the name *Cynthia* was preoccupied, having been used for a genus of insects.* This change has not been generally adopted, but appears to be required. The family name requires a corresponding change.

Polycarpa Heller, 1877.

Body sessile or more or less distinctly pedunculated.

Branchial sac with about four folds on each side. Tentacles simple. Dorsal lamina a plain membrane.

Reproductive organs consist of numerous small hermaphrodite gonads distributed on the inner surface of the mantle, on both sides of the body.

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* Bulletin No. 15, U. S. Nat. Museum, p. 147, 1879.

Polycarpa obtecta Traustedt.

Polycarpa obtecta Traustedt, Vestindiske Ascidiæ Simplices, Aftryk af Vidensk. Meddel. fra den naturh. Foren. i Kjøbenhavn, p. 51, pl. v, figs. 7–8, plate vi, fig 15, 1882.

Polycarpa obtecta Sluiter, Tuniciers recueillis en 1896 par la "Chazalie," Mém. Soc. Zoöl. France, vol. xi, p. 11

Polycarpa multiphiala Verrill, Additions to the Tunicata and Molluscoidea of the Bermudas, these Trans., vol. x, part 2, page 591, 1900; vol. xi, pl. ix, fig. 7, 1901.

PLATE LVII. FIGURES 88, 89 and 92 to 94 inclusive. PLATE LXIII. FIGURES 140 and 144. PLATE LXIV. FIGURES 151 and 153.

Though the type of *P. multiphiala* Verrill differs in some points from Traustedt's description and figures of the West Indian form, other specimens from Bermuda agree with the latter more closely, and I do not think there is sufficient reason for regarding the two species as distinct.

The body usually measures somewhat more in length (that is antero-posteriorly) than in breadth (dorso-ventrally) and is, when not distended with water, decidedly compressed in a lateral direction. The test is tough, yet soft and flexible, rather thin toward the posterior end of the body, but thickened and much toughened near the anterior end, so that the siphons, though in reality fairly well developed (as may be seen when the animal is removed from the test), usually appear very short. The surface is sometimes partly covered with sand and shell fragments, in other cases bare. The inner surface is smooth and nacreous.

The color of the test is a dirty yellowish or brownish gray, often darkening to red, brown, or purplish brown about the apertures.

The animal is usually attached by a very small area near the posterior end, which may be thickened or even produced into a very rudimentary peduncle. Sometimes several individuals are attached together in a loosely connected group.

The largest specimens found do not much exceed 45^{mm} in greatest length. They are somewhat less in breadth, and not over 12 to 15^{mm} in thickness when not distended with water.

The mantle is smooth and rather thin, of a uniform dark brown color. The rather narrow muscle-bands run transversely, longitudinally and obliquely, forming a rather open and regular network. The apertures are distinctly four-lobed. The branchial siphon is the longest.

The tentacles are long and more or less brown-pigmented. Verrill gives 40 as the number in the type specimen of *P. multiphiala*, but this number is sometimes exceeded. They vary somewhat in size, but no very regular arrangement, except an alternation of larger and small ones, is to be distinguished. Traustedt gives 36–40 as the number of tentacles.

The dorsal tubercle is large; the opening is horseshoe-shaped with incurved, but not spirally rolled, horns. (This was the condition in several specimens examined and agrees with Traustedt's description).

Traustedt states that there are 4 folds on the left and 5 on the right side Sluiter mentions one specimen with 4 on each side. This I have found to be the case in most of the Bermuda specimens examined, though in one case a rudimentary fifth fold was present on the right side, next to the dorsal lamina. The folds are generally wide. The one nearest the dorsal lamina is the smallest. The internal longitudinal bars are very wide and flattened They are quite numerous, about four or five occurring between the folds, and sometimes as many as 10 or 11 on one side of a fold. They are separated by 10 or 12 stigmata in the spaces between the folds (14 near the endostyle). This number diminishes to 3 or 4 or less near the summit of the folds, where the bars are so close together that when flattened down against the branchial sac they overlap each other for most of their width, covering the intervening stigmata entirely. The transverse vessels are of various sizes, but are not arranged with great regularity. Small transverse vessels crossing the stigmata without interrupting them are generally wanting.

The alimentary loop is of the same color as the mantle and branchial sac. It forms in some cases a moderately large, open loop; in others a much narrower one (see figs. 92, 93 and 94). The stomach is small. In all cases the alimentary loop is confined to the posterior half of the body.

The gonads are distributed to the number of 20 or more on each side of the body. They are flask-shaped bodies, and are so placed that their orifices are directed toward the atrial siphon. The central part of each is occupied by the ovary, and the oviduct opens at the extreme end of the gonad. The sperm-duct opens on a separate papilla or projection a little distance from the end, and is formed by the union of two branches, one of which runs along each side of the ovary and receives the ducts from the numerous small pyriform testes. (Figs. 88 and 89.) In these figures the ovaries are not fully ripe, and the gonads have an elongated phial-like form. This is one

of the characters upon which Verrill based the species *multiphiala*. When the ovaries are ripe and are distended with large eggs, the gonads become thick and swollen, and resemble in shape those shown in Traustedt's figure, though I have not found them developed to such an extent in any of the Bermuda specimens as was evidently the case in the individual figured by the latter author.

This species was collected both in 1898 and 1901. I obtained a few individuals at Coney Island and Long Bird Island, but it appears to be more common on the reefs than along the shore. A number of large specimens were found washed up on the beach, but still alive, at a place known as the "Scaur," on Somerset Island, May 5th, 1901.

Styela MacLeay, 1824

Body attached, sessile, rarely pedunculated.

Test usually coriaceous.

Branchial sac with four folds on each side, or less. Dorsal lamina a plain membrane. Tentacles simple.

Reproductive organs on both sides of the body, attached to the inner surface of the mantle. Ovaries consist of a small number of elongated glandular tubes. Testes numerous, variously placed in relation to the ovaries.

Styela partita (Stimpson), var. bermudensis, nov.

S partita PLATE LV. FIGURE 69. PLATE LVI. FIGURES 76 to 78 inclusive. PLATE LXIV. FIGURES 147 and 149. *S. partita* var. *bermudensis*. PLATE LV. FIGURES 70 to 75 inclusive. PLATE LXIII. FIGURES 142 and 143.

In Prof. Verrill's list (17) two species of *Styela* are mentioned as having been found at Bermuda; *S. partita* (Stimpson), a species originally described from Boston Harbor, and occurring on the Atlantic Coast of the United States from Massachusetts southward, and the Mediterranean species, *S. canopoides* Heller (4), which has also been recorded from the West Indies by Traustedt (16).

After an examination of about 25 specimens of this genus collected at various points about the Bermuda Islands in 1898 and 1901, including those on which Prof. Verrill based his list, I have come to a somewhat different conclusion. The Bermuda specimens vary a great deal in nearly every character, but I cannot satisfy myself from the material available that more than one species is really represented.

None of the specimens correspond exactly to specimens of *S. partita* from Massachusetts (Wood's Hole); though some bear a very strong external resemblance to them, even to the "alternate striping of red and white in the apertures," mentioned by Verrill, which is characteristic of *S. partita;* but as the differences are hardly tangible enough to base a species on, it seems best to consider the Bermuda form as a subspecies of *S. partita*. The specimen in Prof. Verrill's collection, marked *S. canopoides*, does not differ specifically from the others, though it certainly does correspond well with Heller's (4) and Traustedt's (16) description and figures of that species.

This raises the question as to the status of *S. partita* (Stimpson) as a species, and of its relations to *S. canopoides* and other European forms. Metcalf (11) has expressed the opinion that the New England form is only a variety of *Styela aggregata* of Northern Europe. He has not, however, given any detailed statement of his reasons for this belief. Unquestionably the two species are closely allied, but if the New England form is only a variety of a European species, it would seem more reasonable to regard it as a variety of *S. canopoides*, rather than of *S. aggregata*, especially as the latter is a northern species, while *S. partita* is distinctly southern in its distribution. This is, however, a point which I do not feel in a position to decide without a considerable series of European specimens for comparison, and in the present paper I shall confine myself to the consideration of the relations between the Bermuda and New England forms.

Though *Cynthia* (*Styela*) *partita* was described half a century or more ago, no account or figures of its internal anatomy have been published as far as I am aware.* The following details are from specimens taken at Wood's Hole, Mass., in July, 1901. They were growing attached to the piles of a wharf, in large masses (sometimes 8^{cm} across), which contained as many as a dozen individuals closely crowded together. The attachment was by the posterior end of the body. Where individuals grow singly, they are often attached by the whole ventral surface, or by a large part of it. In such specimens the branchial siphon may be a little back from the anterior end of the body.

The body tapers rather rapidly at the anterior end, and the atrial siphon is placed well forward and also directed more or less ante-

* Except Professor Verrill's figures of the gonads in this volume (pl. IX, figs. 8, *a*, *b*, *c*), 1901.

riorly. The test is tough and coriaceous, of a dirty yellowish color, becoming a purplish brown or red toward the anterior end of the body. It is not very thick at any point. On the outer surface it is finely wrinkled ; within it is smooth and glistening.

The largest of these specimens does not exceed 30^{mm} in length, and most of the individuals are considerably smaller.

When removed from the test the body is ovate, with both the siphons near one end. The mantle is of a yellowish color, and rather thick and opaque, with numerous longitudinal muscle-bands, but few conspicuous bands running in other directions. The internal organs cannot be seen very readily through the mantle.

The tentacles vary in number in different specimens. As a rule the larger the specimen the more tentacles. The individual shown in figure 78 had hardly over 30, those shown in figures 76 and 77 had from 40 to 50. The tentacles are of several sizes. Sometimes they are arranged with some regularity ; one tentacle of a given size being placed midway between two of the next larger size and so on ; but this arrangement is not very strictly adhered to. Often those of the smallest size will be wanting in many of the places where, according to the above scheme, they should occur, or they may be represented by a mere tubercle, so that it is hard to say whether it should be counted as a tentacle or not. No doubt as the individual increases in size these grow out into tentacles.

The dorsal tubercle is variable in size and form, and its orifice had a different shape in each specimen examined, though always some modification of the U-form. The ends were not spirally coiled in any case. Evidently the form of the dorsal tubercle will not do as a specific character in this genus, if indeed it is of much value in any other genus of this family, which I am inclined to doubt.

The branchial sac has four distinct folds. These vary in size relatively to the interspaces in different individuals. Figure 69 shows a section extending clear across one side of the sac near the middle of the body. (Toward the ends of the body, the sac is more contracted and the number of stigmata between the bars becomes smaller.) It is taken from the individual shown in fig. 77, a fully adult and fairly large specimen. In this it will be seen that there are about 10 stigmata in the largest meshes in the interspaces between the folds (14 each side of the endostyle and 8 each side of the dorsal lamina). In the dorsal part of the sac, the bars are more crowded, and the maximum number of stigmata in a mesh is about eight. The first fold begins at the third bar from the endostyle and there are four

bars between the last fold and the dorsal lamina. There are from seven to ten bars between the base and summit of a fold, varying according to its breadth.

The transverse vessels are of four or five sizes : the smallest cross the stigmata at their middle point without interrupting them. In general they are arranged according to the same scheme as the tentacles, a vessel of a given size being located midway between two of the next larger size, but many irregularities occur. The transverse vessels become thicker as the dorsal lamina is approached.

The above may be taken as the average condition of the branchial sac in a fully adult specimen. Considerable individual variation occurs in the distribution and number of internal longitudinal bars on the folds and interspaces, and in the number of stigmata in the meshes formed by them. In many examples it averages one or two less than in the specimen shown in fig. 69. Figs. 147 and 149 show a part of the sac of such a specimen.

Such variations are merely individual peculiarities. In addition, there are also differences due to the age of the animal. The branchial sac in the individual shown in fig. 78 did not differ materially in structure from those of larger specimens, but when still smaller and evidently immature specimens are examined, the structure of the sac is found to be more or less simplified. One or more of the folds may be wanting or present only in a rudimentary condition, and the number of internal longitudinal bars, as well as of the stigmata, becomes reduced.

The intestinal loop is small and the intestine doubles back so that it comes in contact with the stomach near the middle of that organ, or a little posterior to the middle. The rectum is long and its opening has about a dozen rounded lobes, or more strictly, plications of the edge. The stomach is of a brownish orange color, and has from 18 to nearly 30 longitudinal folds in its wall, the number varying according to the age and size of the individual.

The ovaries consist of stout glandular tubes, usually two on each side (one of which may be forked). They pursue a more or less crooked course from near the endostyle (on the left side from near the intestine) and end near the atrial siphon. The sperm ducts accompany them and the openings are close beside those of the oviducts. In some specimens both orifices may be seen to have a lobed or plicated margin similar to that of the rectum, but the lobes are smaller. The testes are elongated, more or less branched organs of small size with enlarged ends. They are arranged along each side of the ova-

ries in varying numbers, and communicate with the sperm duct which follows the ovary by slender connecting ducts. Usually the larger the individual the more numerous and more extensively branched are the testes, though this is not always the case.

After this description of the New England form it will be sufficient to mention the particulars in which the Bermuda variety differs from it.

In the first place, it is of considerably smaller size, the largest specimen obtained measuring 22^{mm} by 10^{mm}. Most of them were hardly more than half this size. It is not unlikely, however, that if the collections had been made later in the season, larger specimens might have been found.

In external form it appears to vary more than the typical *partita*. It is attached either by a small area near the posterior end or by a part or the whole of the ventral surface, and in the latter case the siphons are both situated on the dorsal surface. The character of the surface of the test is very variable; it is generally roughest near the apertures, which are usually more or less prominent, but whether the ridges and wrinkles of the surface are large or small, regularly or irregularly disposed, low and rounded or prominent and sharp-edged, appears to be a character of no specific value.

The color is generally a more or less reddish or brownish yellow, or grayish yellow, becoming brown or red on the upper surface, especially about the siphons. The colors are brighter and the test proportionately thicker and of a more cartilaginous character than in the New England specimens. The striping of the apertures, which many specimens show in common with the typical *partita*, has been mentioned above.

As figs. 71 to 75 indicate, the form of the body and length and position of the siphons are very variable. The mantle is thinner, less muscular, and more transparent, though of a deeper yellow color in most cases, and the tentacles are rather more numerous, but the branchial sac does not appear to differ essentially from that of New England specimens of similar size.

The more usual form of the orifice of the dorsal tubercle is a U or horseshoe-shape, with one horn curved inward and posteriorly, alongside the other, but not spirally coiled. Considerably more complex forms occur, as is also the case in the true *partita*.

The reproductive organs are similar, but the testes are fewer and often are not branched at all, but merely simple elongated bodies.

This form was found in many localities about the islands and on

the reefs, attached to stones and corals. It is nowhere very abundant, nor did I ever find many individuals growing together or near together. Among the places where it was obtained were Coney and Long Bird Islands, Somerset Island, Harrington Sound, and Waterloo, Castle Harbor. One specimen was obtained at Hungry Bay.

Genus **Halocynthia** Verrill, 1879. (**Cynthia** Savigny, 1816.)

Body sessile or very nearly so, sometimes incrusted with sand. Both apertures 4-lobed.

Test coriaceous, rarely cartilaginous, no spicules.

Branchial sac with 6 or more longitudinal folds on each side. Tentacles compound. Dorsal lamina a continuous but sometimes toothed membrane, or it may be provided with a series of languets.

Intestine on left side forming a rather wide loop.

Reproductive organs developed on both sides.

Halocynthia rubrilabia Verrill.

Halocynthia rubrilabia Verrill, Additions to the Tunicata and Molluscoidea of the Bermudas, Trans. Conn. Acad. Sci., vol. x, p. 589, fig. 7, 1900.

Plate LVI. Figure 83. Plate LVII. Figures 86 and 90. Plate LXII. Figure 133. Plate LXIV. Figures 150 and 152.

Body swollen, oblong or ovate, usually longer than high, attached by the entire ventral surface or by a larger or smaller area near the posterior end which may be produced into a rudimentary peduncle. Siphons of variable length, widely separated, the branchial generally longer than the atrial.

Size 35 to 50^{mm} long, 25 to 30^{mm} high, 20 to 25^{mm} wide.

Test thick and firm (in many specimens remarkably so), deeply and irregularly wrinkled, in large specimens often so covered with extraneous matter that its reddish color shows only faintly. Apertures similar, 4-lobed, the test about them roughly nodulose or warty.

Mantle very muscular, especially on the right side; the muscle bands, of which the longitudinal are the most conspicuous, form a rather irregular, close, opaque network. Many oblique as well as transverse bands occur also. The mantle is yellow with a reddish tinge, usually becoming bright red on the siphons.

Tentacles all simply pinnate, about 20 in number and of various sizes; the larger ones number about a dozen and are thick, tapering to a point and provided with a row of simple pinnæ along each side. Dorsal tubercle U-shaped, with more or less spirally coiled horns, which may be both incurved or both curved to the right or left.

The branchial sac has 6 wide folds on each side separated by narrow interspaces on which there are but four or five internal longitudinal bars. There are, however, about 7 or 8 bars on the spaces each side of the endostyle and dorsal lamina. The bars are wide and flattened and placed near together, being separated by only four or five stigmata in the spaces between the folds and by a less number on the folds. Between the base and summit of the folds there are sometimes as many as 14 or 15 bars. The stigmata are short and rather wide.

The transverse vessels are mostly of about the same size with an occasional much larger one. In addition there are the usual fine vessels which cross the middle of the stigmata. There is often much red pigment on the vessels of the sac. The dorsal lamina is provided with a series of slender tentacle-like languets.

Prof. Verrill states that the anus has about 12 lobes. This is not of value as a specific character. One specimen had but 4 barely perceptible lobes. The intestine forms a broad loop. The stomach is but little enlarged and is partly covered by the large greenish hepatic gland which lies dorsal to it.

The reproductive glands are irregularly lobulated or foliated bodies arranged along each side of the genital ducts. When much enlarged they are so crowded that their serial arrangement is not very apparent. On the left side one series of the glands lies within the intestinal loop. Another set lies along the dorsal side of the intestine, the duct following close along the intestine and the glands lying only along one side of it, while in the case of those which lie within the loop, as well as the single set which is present on the right side of the body, they lie on each side of the duct.

This appears to be the commonest member of the family at Bermuda, at least in shallow water, where it is found adhering to stones, shells, corals, etc.

Halocynthia riiseana (Traustedt) var. munita, nov.

PLATE LVI. FIGURE 84. PLATE LVII. FIGURES 85 and 87.
PLATE LXIII. FIGURE 141.

In addition to *H. rubrilabia* there is another species of the genus found at Bermuda, but it is much less common. It was only poorly represented by one or two small specimens in Prof. Verrill's collection and he considered it identical with Traustedt's West Indian species, *Cynthia Riiseana*. In 1901, I obtained three good sized specimens, of which the largest measures 28^{mm} by 25^{mm}. The others

were not much smaller. They were growing attached to stones along the shores of Coney Island and Long Bird Island.

From these, though the material is too scanty to give a satisfactory idea of the individual variations which specimens of this species are likely to exhibit, I believe that the Bermuda form is sufficiently different from the West Indian one to justify its description, provisionally at least, as a new variety.

The body is ovate, slightly longer than deep, and decidedly compressed laterally. The test is not thick; it is soft and flexible, light colored, and would be translucent were it not for the dense coating of sand and shell fragments which cover not only the surface, but are more or less buried in the test substance. The area of attachment is small. The siphons are wide apart in two specimens, in the other they are rather near together. They are rather short in all cases. The appearance of the animals is rather that of a *Molgula* than one of the family to which they really belong.

The mantle is thin and more or less transparent with weak musculature. In one specimen the tips of the siphons are pink. None of the other specimens show any red color on any part of the body.

In all these particulars the examples differ from Traustedt's description, in which the test is described as leatherly with a wrinkled surface, and the mantle musculature as very strong.

There are about a dozen large tentacles beside some smaller ones. They differ greatly from those of *H. rubrilabia*, the largest ones being bipinnate (fig. 84). The dorsal tubercle, in the specimen in which I examined it, had a U-shaped aperture with one horn incurved, but not sufficiently to form a spiral. The dorsal lamina is provided with numerous tentacular languets. They begin a little way back from the anterior end, the lamina being plain for a little distance.

As in the last described form, there are six branchial folds on each side. There are, however, fewer internal longitudinal bars (I counted only ten or eleven on one side of one of the longest folds) and they are separated by 7 or 8 or even 9 stigmata in the meshes on the interspaces between the folds, instead of 4 or 5 as in *H. rubrilabia*. The stigmata are also longer and narrower than in that species, but in other respects the branchial sac resembles that of *H. rubrilabia*.

The intestinal loop is rather narrower than in that species and the reproductive organs differ, the gonads being spherical though arranged in a similar manner along each side of the genital ducts, with which they communicate by short branch ducts. There is only one series of reproductive organs on each side. On the left side it lies within the intestinal loop.

Microcosmus Heller, 1877.

Distinguished from *Halocynthia* by the plain, untoothed dorsal lamina, and by the narrow intestinal loop.

Microcosmus miniatus Verrill.

Microcosmus miniatus Verrill, Additions to the Tunicata and Molluscoidea of the Bermudas, Trans. Conn. Acad Sci., vol. x, p 590, 1900.

PLATE LVI. FIGURE 79. PLATE LVII. FIGURES 91 and 95. PLATE LXII. FIGURES 129 and 130. PLATE LXIV. FIGURE 148.

Test more or less completely red or dull orange-red externally, rather thick and tough, somewhat cartilaginous. In adult specimens it is much wrinkled and raised (especially on the dorsal surface and about the apertures) into prominent ridges with sharp rough edges. Young specimens are much smoother.

The shape is ovate, more or less elongated; the apertures are widely separated. The attachment is by an area of considerable extent on the ventral side, generally near the posterior end. In external appearance this species closely resembles *Halocynthia rubrilabia*, described above, but is usually colored more intensely and extensively red than that species, and the body is often somewhat more elongated. Internally the test is smooth and pearly and less deeply colored than on the outside.

Size of the largest specimen, 50 by 35 by 25^{mm}.

Removed from the test, the animal is ovate with very widely separated and divergent siphons of very variable size and length in different specimens, both four-lobed. The mantle, especially near the apertures, is more or less tinged with red. Its muscles, stronger on the dorsal part of the body, are gathered into very distinct and moderately thick bands, which for the most part cross each other nearly at right angles and form a rather open network, so that the internal organs are more or less distinctly visible through the mantle.

The tentacles are bipinnately branched. There are about 8 or 10 larger ones alternating with others of smaller size and between them are a variable number of still smaller ones. Even the smallest are somewhat branched. The aperture of the dorsal tubercle had spirally incurved horns in the specimens examined.

The number and arrangement of the folds of the branchial sac proved to be quite constant in a number of individuals of various sizes from about 15^{mm} in length up to individuals of full size. There are nine folds on each side of the sac, but the last one (that nearest the

endostyle) usually reaches only one-quarter or one-third of the distance back from the anterior end, and is often so rudimentary that it is easily overlooked. It is apt to be smaller on the left than on the right side of the body. The eighth fold is generally fairly large and of full length.

As a rule there are four or five internal longitudinal bars in the spaces between the folds and these are separated by from 5 to 8 stigmata. Along one side of a fold, from the base to the summit, there may be a dozen bars (if the fold is a large one), and the number of stigmata between them diminishes from about four near the base to three or two at the summit. The transverse vessels are numerous and rather stout, and the stigmata consequently are not very greatly elongated. There are various sizes of the transverse vessels but apparently no regular scheme in their arrangement The smallest ones usually cross the stigmata without interrupting them. The larger ones have more or less conspicuous membranes attached to them.

The intestinal loop is very long and narrow, and the two portions lie in contact with each other for the greater part of the distance. The two dark colored hepatic glands lie close against and partially covering the stomach.

The reproductive organs consist of about four double clusters of follicles lying along and extending each side of a slender curved duct, which runs toward the atrial aperture. On the left side one group of follicles lies within the bend of the intestinal loop, the others outside of and dorsal to it and anterior to the rectum.

Fairly common on the reefs and attached to the under side of stones along the shores. Collected both in 1898 and 1901.

This species is closely allied to the West Indian species *M. variegatus* Heller, which is also described and figured in Traustedt's (16) work on the West Indian Simple Ascidians. That species has from 8 to 10 branchial folds, of which three are short and only reach a part of the distance toward the posterior end of the sac. According to Traustedt's figure, it also has very large siphons, but this is a character which varies not only in different individuals, but is largely determined by the state of contraction of the specimen, and would hardly serve to separate the species; while the differences in color are easily explained by the fact that Heller and Traustedt undoubtedly wrote their descriptions from faded alcoholic specimens. The condition of the branchial folds seems, therefore, to be the chief distinguishing character. I have found this to be practically constant in a number of specimens of the present species.

Family **ASCIDIIDÆ** Herdman, 1880.

Body usually sessile, rarely pedunculated. Branchial aperture generally 8-lobed; atrial generally 6-lobed. Test gelatinous or cartilaginous, rarely chitinous or horny.

Branchial sac without folds. Internal longitudinal bars present and usually papillated. Stigmata straight or curved. Tentacles simple.

Alimentary canal on one side of the branchial sac, sometimes extending posteriorly beyond it to a slight extent.

Reproductive organs placed close against or within the intestinal loop.

Genus **Ascidia** Linn., 1767.

Body attached, sessile, rarely pedunculated; surface bare or incrusted with sand. Branchial and atrial apertures placed far apart, usually 8-lobed and 6-lobed respectively.

Test cartilaginous, membranous, or gelatinous, soft or hard, usually crowded with bladder-cells.

Branchial sac sometimes minutely plicated. Stigmata straight. Internal longitudinal bars generally papillated.

Dorsal lamina a continuous membrane, which may be provided with transverse ribs or with teeth. It is continued behind the œsophageal aperture.

Alimentary canal and reproductive organs on the left side of the body.

Ascidia atra Lesueur.

Ascidia atra Lesueur, Descriptions of several new species of Ascidia, Journ. Acad. Nat. Sci. of Philadelphia, vol. iii, pt. 1, p. 2, pl. i, fig. 2, 1823.

Ascidia nigra Sav.; Herdman, Prelim. Rep. Challenger, Proc. Royal Soc. Edinb., vol. ix, pp. 460 and 466, 1880.

Phallusia atra Lesueur; Traustedt, Vestindiske Ascidiae Simplices, Aftryk af Vidensk. Meddel. fra den naturh. Foren. i Kjobenhavn, p. 22, pl. iv, fig. 6, and pl. v, fig. 17, 1881.

Ascidia nigra Sav.; Herdman, Rep. Voy. Challenger (Zoöl.), vol. vi, part xvii, p. 210, 1882.

Ascidia atra Lesueur; Sluiter, Tuniciers recueillis dans la Mer des Antilles, etc., Mém. Soc. Zoöl. de France, vol. 11, p. 7, 1898.

Plate LXIII. Figures 188 and 189.

The body is only moderately elongated, with large, anteriorly directed siphons which often have more than the normal number of lobes to the apertures. It is usually attached by the posterior end,

but sometimes by the left side. Its most conspicuous character is the abundant blue-black pigment which colors the test and many of the internal organs as well. In very young specimens the test is nearly colorless and transparent, but the dark pigment begins to appear while the individual is still very small.

The largest specimen obtained at Bermuda measured about 70x30^{mm}. In the West Indies it attains a considerably larger size.

The branchial sac tapers posteriorly. The internal longitudinal bars are provided with curved papillæ somewhat similar to those of *A. curvata* Traustedt illustrated below, but rather longer and more curved. They have a narrow membrane attached to the concave side. According to Traustedt the papillæ are bifid at the extremity This does not appear to be common in the Bermuda specimens. There are about five or six stigmata in a mesh, and the sac exhibits minute undulations or plications between the internal longitudinal bars. The transverse vessels alternate in size. In addition there are much thicker ones at intervals.

The tentacles are numerous and slender, of several sizes, arranged with some degree of regularity. The dorsal tubercle generally has a U-shaped opening

This species is common on the reefs and at a little distance much resembles a kind of sponge which abounds there. As already mentioned, the individuals found were of small size compared to those occurring in the West Indies.

It is questionable whether this form is distinct from *Phallusia nigra* Savigny, a European and Red Sea species. As far as I am aware, the only distinction between the two is that the European form has small intermediate papillæ on the internal longitudinal bars, midway between the transverse vessels Both Traustedt and Sluiter mention their absence in the West Indian form, and I have failed to find them, even in the largest of the Bermuda specimens which I examined.

Herdman (6), though aware of Traustedt's observation, identifies the Bermuda form with Savigny's species, and mentions intermediate papillæ as present in parts of the branchial sac. He does not, however, expressly state that he found them in American specimens, and later may have changed his opinion, as in his Revised Classification of the Tunicata (7) he lists *A. nigra* Savigny and *A. atra* Lesueur as distinct species. *Phallusia violacea* Gould, from Rio Janiero, Brazil, may be identical with this species.*

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* U. S. Exploring Expedition, Mollusks and Shells, p. 495, fig. 610

Ascidia curvata Traustedt.

Ascidia curvata Traustedt, Vestindiske Ascidiæ Simplices, Aftryk af Vidensk. Meddel. fra den naturh. Foren i Kjobenhavn, p. 25, pl. iv, figs. 8, 9, and 10, and pl. v, fig. 19, 1881.

PLATE LVI. FIGURES 80, 81 and 82. PLATE LXIII. FIGURES 145 and 146.

The body is much more elongated than in the last species and tapers gradually toward the anterior end. It is strongly flattened laterally. The atrial siphon is generally situated behind the middle of the body Both siphons are usually long and often turned to the right, the animal being generally attached by the entire left surface. Great variations in the external form of the body are common. The largest specimen measures about 50^{mm} in length and half as much in a dorso-ventral direction.

The test is greyish or practically colorless and transparent, soft and gelatinous, moderately thick on the right side but very thin and easily torn on the left side. Its surface may be smooth and glossy, allowing much of the internal structure to be seen, or it may be wrinkled or in some cases so incrusted with sand and shell fragments that nothing can be seen through it. The apertures generally have about the number of lobes characteristic of the genus, but they are not readily counted in the contracted state of the orifices. There are markings of light orange brown about the apertures in the living animal.

The mantle is very delicate and transparent. On the right side there are numerous but very slender muscle-bands, mostly transverse or only slightly oblique. They taper off and end soon after passing the median line on the dorsal and ventral surface, leaving the left side practically free from muscle bands except the sphincter muscles of the siphons, which are composed of similar delicate bands placed close together. Very few longitudinal bands are present.

The tentacles are numerous and placed close together, slender and uniformly tapering, of several sizes. The dorsal tubercle is small, U-shaped.

The branchial sac extends for a long distance behind the œsophageal opening. Its internal longitudinal bars are separated by 4 or 5 stigmata ; 8 or 10 stigmata intervene between the dorsal lamina and the first bar on each side of it. In some places the transverse vessels are nearly equal in size, in other parts (especially in the posterior portion of the sac) they show more or less tendency to alternate in size. Very large vessels, such as are shown in Traustedt's

figure, do not appear to be frequent. The papillæ are rather stout, of moderate length and somewhat curved. Their ends are obtuse. Those opposite the smaller transverse vessels are smaller. These small transverse vessels are occasionally interrupted and rudimentary though the corresponding papillæ may be present and well developed.

In most parts of the sac there is little or no sign of the undulation or plication common in this genus, the sac being almost flat, but individuals vary in this respect. On the whole the branchial sac is of a simple type Horizontal membranes are developed only on each side of the dorsal lamina and to a very slight degree on the adjacent parts of the sac. Elsewhere they are inconspicuous or wanting The dorsal lamina is often nearly plain-edged for most of its length. In other cases it is finely denticulated in the posterior portion of the body.

The stomach and intestine are proportionately small and form a very compact and short loop. The stomach has a few longitudinal folds and during life is of an orange color This color may also extend to part of the intestinal loop.

The reproductive organs lie between the stomach and intestine and the branchial sac. The duct follows the rectum and ends near the anal opening.

This species was found at Coney Island, Long Bird Island, in Harrington Sound, at Somerset Island, and many other places, attached to stones, shells, etc. It is one of the commonest simple ascidians at Bermuda. Traustedt's specimen (he appears to have had but one) was from St. Thomas, W. I.

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EXPLANATION OF PLATES XLVIII-LXIV.

The figures showing entire zooids were in all cases drawn with the aid of a camera lucida, as far as the outlines of the body and the principal organs are concerned; the smaller details were necessarily filled in without it. The magnification of the figures of zoöids is uniform; 32 diameters, except in the case of a few forms with zoöids too large to admit of this. It is hoped that these figures will give a better conception of the relative sizes of the zoöids than simple measurements, as the latter fail to give any idea of the state of contraction the animal is in. It has not been possible to get fully expanded specimens in the case of most species, but the degree of contraction, of the thorax at least, may be judged by the course of the endostyle, which is crooked or convoluted in the contracted state, but straight or nearly so when the animal is fully expanded. In all cases they have been represented as if transparent to show the internal structure.

The figures showing spicules are also (with the exception of those of *Cystodytes* and *Echinoclinum*) drawn to a uniform scale, a magnification of 450 diameters, and all were drawn with a camera lucida. In selecting spicules for illustration, neither the largest nor the smallest, nor the extremes of variation in form to be found in the colony, were chosen, but a group was selected that would give a fair idea of the forms and sizes most characteristic of the species or variety.

In regard to the photographs of the simple ascidians, it may not be out of place to say that all the Bermuda species vary endlessly in their external characters and shape, and the writer would caution against the belief that even very great differences in these characters, from the specimens illustrated, are necessarily indicative of difference in species. With the exception of a few (mentioned in the descriptions of the figures), which were taken from living specimens by Mr. A. Hyatt Verrill, all the photographs were made from specimens preserved in formalin.

I am indebted to Prof. A. E. Verrill for the use of the photographs from which plate lxiv and also figs. 188 and 189 were made.

PLATE XLVI.

Figure 1.—*Clavelina oblonga* Herdman. Zoöid containing embryos and larvae seen from the right side. × 12. Page 334

Figure 2.—*Distoma capsulatum* n. sp. Zooid seen from the left side; showing the arrangement of the mantle muscles. × 32 Page 341.

Figure 3.—*Rhodozona picta* (Verrill). Zoöid seen from the left side. × 8. Page 335.

PLATE XLVII.

Figure 4.—*Ecteinascidia turbinata* Herdman. Young individual with no reproductive organs developed. Seen from the left side. × 16. Page 338.

Figure 5.—*Rhodozona picta* (Verrill). Side view of thorax to show the arrangement of the muscle bands in the mantle. × 9. Page 335.

Figure 6.—*Ecteinascidia turbinata* Herdman. Colony of adult individuals Two-thirds the natural size. (After Herdman.) Page 338.

Figure 7.—*Clavelina oblonga* Herdman. Colony of four individuals, the two on the left being expanded, the others contracted as usual in preserved specimens. × 2. Page 334.

Figure 8.—*Perophora viridis* Verrill. Individual seen from the left side, showing outline of test and part of the branching stolen. × 32. Page 337.

PLATE XLVIII.

Figure 9.—*Distoma olivaceum*, n. sp. Zoöid seen from the left side. Showing the arrangement of the back pigment dots on the mantle (chiefly on the thorax). × 32. Musculature of mantle not shown. Page 344.

Figure 10.—*Distoma clarum*, n. sp. Zoöid seen from the left side, containing large eggs and larvae. Showing muscle bands of mantle. × 32. Page 345.

Figure 11.—*Distoma obscuratum*, n. sp. Zoöid (much contracted) seen from the left side. × 32. Musculature of mantle not shown. Page 343.

Figure 12.—*Cystodytes violaceus*, n. sp. Zoöid (much contracted) seen from the left dorsal aspect, containing two large eggs. Rectum containing pellets of undigested matter. ×32. Page 348.

Figure 13.—*Cystodytes violaceus*. Small spicules which are scattered in the test. ×40. Page 348.

Figure 14.—*Cystodytes violaceus*. Large spicules forming the capsules about the zoöids, but occurring to some extent elsewhere in the test. ×40. Page 348.

PLATE XLIX.

Figure 15.—*Distaplia bermudensis*, n. sp. Zoöid seen from the right side, showing the muscle bands of the mantle. ×32. *i. tr*=intermediate transverse vessel of branchial sac. Page 349

Figure 16.—*Distoma convexum*, n. sp. Zooid seen from the left side, showing arrangement of brown pigment spots on the mantle. ×32. Musculature of mantle not shown. Page 342.

Figure 17.—*Cystodytes draschii* Herdman. Zoöid seen from the left side. ×32. Page 347.

Figures 18 and 19.—*Distaplia bermudensis*, n. sp. Colony of the flattened incrusting form showing the arrangement of the zooids. Side and top view. ×2. Page 349.

PLATE L.

Figure 20.—*Amaroucium bermudæ*, n. sp. Zoöid with short post-abdomen, seen from the right side. Dorsal languets not represented in the figure. Ovary not developed. *e c.*=large ectoderm cells on the mantle. ×32. Page 352.

Figure 21.—*Amaroucium exile*, n. sp. Zoöid seen from the left side containing a large embryo. Dorsal languets not represented. ×32. Page 354.

Figure 22.—*Symplegma viride* Herdman. Colony, two-thirds the natural size. (After Herdman.) Page 378.

Figure 23.—*Echinoclinum verrilli*, n. sp. Entire colony incrusting a branching alga, showing distribution of zoöids and spicules. ×2. Page 372.

Figure 24.—*Echinoclinum verrilli*. Zoöid seen from the left side. No reproductive organs developed. ×32. Page 372.

Figure 25.—*Echinoclinum verrilli*. Spicules from the test. ×225. Page 372.

PLATE LI.

Figure 26.—*Didemnum lucidum*, n. sp. Spicules. ×450. Page 360.

Figure 27.—*Didemnum savignii* Herdman. Spicules. ×450. Page 358.

Figure 28.—*Didemnum lucidum*, n. sp. Colony incrusting a branching alga, showing distribution of zoöids and spicules. ×2. Page 360.

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Figure 30.—*Didemnum atrocanum*, n. sp. Spicules. ×450. Page 359.

Figure 31.—*Didemnum solidum*, n. sp. Spicule. ×450. Page 358.

Figure 32.—*Didemnum orbiculatum*, n. sp. Spicules. ×450. Page 361.

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Figure 34.—*Didemnum atrocanum*, n. sp. Zoöid seen from the right side. ×32. Page 359.

Figure 35.—*Didemnum savignii* Herdman. Zoöid seen from the left side. ×32. Page 358.

Figure 36.—*Didemnum solidum*, n. sp. Zoöid seen from the right side. ×32. Page 358.

Figure 37.—*Didemnum lucidum*, n. sp. Zoöid seen from the left side. No reproductive organs developed. ×32. Page 360.

Figure 38.—*Didemnum orbiculatum*, n. sp. Zoöid seen from the left side. The female reproductive organs only are developed. ×32. Page 361.

PLATE LII.

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Figure 41.—*Leptoclinum albidum* Verrill. From the Bay of Fundy. Spicules. ×450. (Introduced for comparison.) Page 363.

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Figures 43 and 44.—*Leptoclinum speciosum* var. nov. *hamiltoni*. Spicules from two different colonies. ×450. (See also figure 47.) Page 365.

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Figure 47.—*Leptoclinum speciosum*, var. nov. *hamiltoni*. Spicules (×450) with thicker points than those shown in figures 43 and 44. Page 365.

Figure 48.—*Leptoclinum speciosum*, var. nov. *somersi*. Spicules. ×450. Page 366.

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Figure 50.—*Leptoclinum speciosum*, var. nov. *bermudense*. Zoöid seen from left side. ×32. Page 364.

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Figure 54.—*Botrylloides nigrum* Herdman. Zoöid seen from the right side. No reproductive organs developed. Page 374.

Figure 55.—*Botrylloides nigrum*, var. nov. *planum*. Zoöid seen from above (from the dorsal side). ×32. Page 377.

Figure 56.—*Diplosoma atropunctatum*, n. sp. Zoöid seen from the left side. ×32. Page 370.

Figure 57.—*Diplosomoides fragile*, n. sp. Zoöid seen from the left side, fully expanded. ×32. Page 370.

Figure 58.—*Diplosomoides fragile*. Spicules. ×450. Page 370.

Figure 59.—*Diplosoma lacteum*, n. sp. Zoöid seen from the left side. ×32. Page 369.

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Figure 62.—*Polysyncraton amethysteum*, n. sp. Zoöid seen from the left side, showing the muscle bands in the mantle. ×32. Page 366.

Figure 63.—*Michaelsenia tincta*, n. sp. Part of the endostyle and two of the folds of the branchial sac. Showing internal longitudinal bars. ×48. Page 381.

Figure 64.—*Polysyncraton amethysteum*, n. sp. Spicules. ×450. (See also figure 67.) Page 366.

Figure 65.—*Polysyncraton amethysteum*. Upper surface of part of a colony including the branchial orifices of two zoöids. Showing the distribution of the spicules, which are confined to the upper surface of the colony. ×16. Page 366.

Figure 66.—*Polysyncraton amethysteum*. Zoöid seen from the anterior end, containing a large egg; showing displacement of the coils of the vas deferens due to the enormous development of the egg, which has reached its full size. ×32. Page 366.

Figure 67.—*Polysyncraton amethysteum*. Spicules from a colony in which they average of smaller and more uniform size than those shown in figure 64. ×450. Page 366.

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Figure 70.—*Styela partita*, var. nov. *bermudensis*. Part of the branchial sac from near the middle of the body extending from the endostyle to the dorsal lamina. ×10. (Taken from the specimen shown in figure 72.) Page 388.

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Figures 76, 77 and 78.—*Styela partita* (Stimpson) from Wood's Hole, Mass. Three individuals, showing the outlines of the body when removed from the test, the alimentary canal and the reproductive organs of the left and right sides. ×1⅓. Page 389.

Figure 79.—*Microcosmus miniatus* Verrill. Tentacle. ×about 36. Page 396.

Figure 80.—*Ascidia curvata* Traustedt. Small part of the branchial sac showing part of the dorsal lamina. From the posterior part of the body. ×40 (*h. m.* = horizontal membrane of transverse vessel.) Page 400.

Figure 81.—*Ascidia curvata* Traustedt. Small individual seen from the right side showing the outline of the test and the muscle bands of the mantle, also the papillae of the branchial sac. The alimentary canal and reproductive organs, situated on the left side, are visible through the transparent tissues. ×4. Page 400.

Figure 82.—*Ascidia curvata* Traustedt. Anterior end of the dorsal lamina and adjacent part of the branchial sac, dorsal tubercle and part of the tentacles. ×20. (*h. m.*=horizontal membrane of transverse vessel.) Page 400

Figure 83.—*Halocynthia rubrilabia* Verrill. Tentacle. ×about 36. Page 393.

Figure 84.—*Halocynthia riiseana* (Traustedt), var. nov. *munita*. Tentacle ×about 36. Page 394.

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Figure 86.—*Halocynthia rubrilabia* Verrill. Outline of individual (removed from the test) showing alimentary and reproductive organs of both sides. ×1⅓. Page 393.

Figure 87.—*Halocynthia riiseana* var. nov. *munita*. Outline of individual (removed from the test) showing alimentary and reproductive organs of both sides. ×1⅓. Page 394.

Figures 88 and 89.—*Polycarpa obtecta* Traustedt. Two polycarps. The ovaries are not fully ripe, and the eggs and ovaries themselves are small. ×32. Page 396.

Figure 90.—*Halocynthia rubrilabia* Verrill. Small piece of the branchial sac from one of the spaces between two folds near the middle of the body. ×24. Page 393.

Figure 91.—*Microcosmus miniatus* Verrill. Outline of individual (removed from the test) showing alimentary and reproductive organs of both sides. Two-thirds the natural size. Page 396.

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Figure 95.—*Microcosmus miniatus* Verrill. Small piece of the branchial sac from one of the spaces between two folds near the middle of the body. ×24. Page 396.

Plate LVIII.

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Figure 98.—*Amaroucium exile*, n. sp. Two colonies seen from above. Page 354.

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Figure 151.—*Polycarpa obtecta* Traustedt. Small piece of the branchial sac (showing two internal longitudinal bars) from one of the spaces between two folds near the middle of the sac × 30 Page 386.

Figure 152.—*Halocynthia rubrilabia* Verrill. Specimen cut transversely. Slightly enlarged. Page 393

Figure 153.—*Polycarpa obtecta* Traustedt. Small piece of the mantle showing longitudinal, transverse and oblique muscle bands. × about 30. Page 386.

ABBREVIATIONS

[For explanation of any other abbreviations, see description of figure.]

at.	atrial aperture.	od.	oviduct.
br.	branchial aperture	oe.	œsophagus
d. l.	dorsal lamina.	ov	ovary
d. lg.	dorsal languet	p	papilla
d. t	dorsal tubercle.	p. c.	pigment cell
em.	embryo	pcp.	polycarp
en.	endostyle	p. s.	pigment spot.
fd.	fold.	r.	rectum
g.	ganglion.	rep.	reproductive glands.
g. c.	gastric cœcum.	sg.	stigma.
h.	heart	st	stomach
h. g.	hepatic gland.	t	testes.
in.	intestine.	tn.	tentacle.
i. l. b.	internal long. bar.	tr. v.	transverse vessel.
lg.	languet.	ty.	typhlosole.
lv.	larva.	v. ap.	vascular appendage.
m. a.	muscular appendage.	v. d.	vas deferens
m. b	muscle band.		

TRANSACTIONS

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X.—The Bermuda Islands: their Scenery, Climate, Productions, Physiography, Natural History, and Geology; with Sketches of their Early History and the Changes Due to Man.*

By Addison E. Verrill.

In the preparation of the following descriptive account of the Bermuda Islands, I have aimed to provide a work that may meet most of the needs of large numbers of persons who go to the islands annually for health, pleasure, or study, and who may wish to learn as much as possible about the islands and their principal productions, without being obliged to consult a library, or burden themselves with many books.†

At the same time I have tried to make it so comprehensive and accurate, both as to text and illustrations, that it may serve as a standard reference book for students and libraries generally, in respect to the various subjects treated, though many of them are here necessarily treated rather briefly.

In regard to the Marine Zoölogy, which is a very extensive subject, requiring hundreds of additional illustrations, the rather brief and general accounts here included are intended to be in a popular form, and to illustrate the more conspicuous and important species, such as visitors are likely to meet with and wish to know about. But I do not intend to give here complete lists of the species in any of the larger groups, for that would require a large volume.‡

Much fuller accounts of the Marine Zoölogy will be provided in a series of monographs now being prepared by the author and others. Some of these have already been published, and others are nearly ready for the press.§

The observations and collections on which this work is based were chiefly made during two expeditions to the Bermudas: one made in the spring of 1898, when I was accompanied by three students from

† It should be understood that most of the fishes and other marine animals and much of the vegetation are identical with those of the Bahamas, Porto Rico, and other West Indian Islands, so that this work will also be useful in any of these islands.

‡ The total number of marine species now known is over 1000. Of fishes there are about 200 species.

§ See the Bibliography at the end of this work.

the Sheffield Scientific School of Yale University, viz. Messrs. C. M. Cook, Jr., Clarence S. Verrill, and Wm. E. Porter, who did most excellent and valuable work in helping me to gather very large collections; and another expedition, made in the spring of 1901, with my son, A. Hyatt Verrill, who not only made large collections, but also made numerous colored drawings of the soft-bodied marine forms, and about 200 excellent photographs, both geological and zoölogical, including numerous photographs of living animals beneath the water, and of living birds in their natural haunts. For a short time we were joined by Dr. W. G. Van Name, who devoted himself mainly to the Tunicata, and has since published a monograph of them

Besides the two large collections, made by myself and parties, I have had for study, during many years, collections made by Messrs. J Matthew Jones, G. Brown Goode, and others.

For historical subjects, I have consulted numerous works,* and have quoted verbatim from some of them, when it seemed desirable to preserve the exact wording and quaint spelling of the early writers. The Memorials of Bermuda, by Governor Lefroy, 2 volumes, 1877, is by far the most important work for the early history of the islands, and I have quoted from it freely.

In some respects the Bermuda Islands are almost unique. Very few other islands, of similar size and situated in a favorable climate, were destitute of aborigines when discovered by Europeans. Apparently man had never set foot on the Bermudas until they were discovered by the Spaniards, about 1510. The number of species of land animals and plants peculiar to the Bermudas is unusually small for islands of this character. No other islands situated so far from the equator are surrounded by living coral-reefs, and the hills of drifted and hardened shell-sand are unusually high for such a formation.

The outer-reefs, with their enclosed lagoons, resemble the coral islands or atolls of the Pacific, but they are not of the same nature. They are the eroded remains of limestone islands, once of large size and considerable height, like those still left, but much larger. They may, therefore, be called *pseudatolls*.

During recent years these islands have been much visited by Americans, during the winter and spring months, either for health or pleasure, or both. This is partly due to the fact that they have become much better known than formerly, and perhaps still more to

* For the titles of the more important historical works, see the Bibliography, at the end of this work.

the greater facilities for reaching the islands and the excellent hotels now established there.* At present about three thousand Americans visit the islands every winter, and the number is rapidly increasing.

The smooth and romantic roads are ideal places for driving and cycling. The transparent waters of the nearly enclosed harbors and bays afford excellent places for boating, yachting, and fishing. The beautiful views available for artists are endless, but the glorious colors of the waters and sky are beyond the dreams of art.

Many visitors to the islands are naturally more or less interested in the unfamiliar or novel character of the subtropical vegetation; in the unusual forms of animal life abounding in the sea, or on the coral reefs; and in the strange geological phenomena, as displayed in the curiously eroded cliffs and pinnacles of the shores; in the grottoes and caverns hung with huge stalactites, and with clear blue sea-water beneath; in the curious limestone formations, seen even in the deep cuts made for the highways; and in the ever moving sand-dunes, composed of wind-drifted white shell-sand. Many other unusual effects are due to the peculiar structure of the islands, where the only rock is limestone, made from corals and shells, and the only soil is an insoluble residue left after the decomposition of this limestone, but yet sufficiently abundant and fertile to support luxuriant vegetation.

The association of some of the localities with the poems of Thomas Moore, who resided here four months in 1804, is a source of interest to many visitors. Those who are historically inclined can also find much of interest in connection with the ruined forts on the distant uninhabited islands and in the antiquated buildings at St. George's and elsewhere, as well as in the ancient records of the colony.

Many professional naturalists and scientific students visit the islands, because they are so favorably situated for the study of tropical and subtropical life, and especially because the facilities for studying living reef-corals and the various forms of life associated with them on the coral reefs are here exceptionally favorable, and the climate is agreeable and more healthy than on most tropical and subtropical islands. The people are also very hospitable and kindly disposed toward scientific visitors.

Bright colored tropical fishes can also be easily procured here, and many have been taken hence to New York, to stock the public aquarium in the old Castle Garden.

* The distance from New York is 675 nautical miles, and the passenger steamers of the Quebec Line usually make the trip in fifty to sixty hours.

Many of these fishes take the hook readily, and afford excellent sport for those who are fond of sea-fishing. Among those that are most esteemed for the table are the Green Angel-fishes, Rockfishes, sometimes of great size, Groupers, Grunts of several kinds, Snappers, Bonito, Guelly, Hogfish, Amberfish, Gogglers, and many other.

Part I.—General Descriptions of the Scenery, Climate, Harbors, Waters, Vegetation, Birds, Roads, Historical Localities, Ruined Forts, etc.

These islands are situated east of the main current of the Gulf Stream, but yet so near it that their shores are always bathed in the pure blue, warm Gulf Stream water, and for this reason the climate is remarkably equable for this latitude. Frost is practically unknown, though light frosts have occurred a very few times, at long intervals. Temperatures slightly below 50° F. are not infrequent in winter.

The winter months and March are cool, the average temperature being from 59.5° to 60.5° F. and there are many chilly, windy, and rainy days, especially with northerly winds, when one needs thick clothing out of doors, and artificial heat within. Indeed, many visitors from the north find it much cooler than they had expected, and are disappointed in not being able to wear thin clothes all the time. It is not well to trust in this case too much to the poetic descriptions of enthusiasts. Persons in feeble health should always secure rooms that can be heated when necessary and should have woolen clothing. April and May, and the first half of June, are the most delightful months. In midsummer the air becomes very moist and sultry, but not very hot, seldom exceeding 87° F. The climate will be more fully discussed in a later chapter.*

The Bermudas are nearly due east of Charleston, S. C., and 575 nautical miles from Cape Hatteras, which is the nearest land. From

* The following lines, from a beautiful poem of Thomas Moore, would indicate a warmer climate than actually exists there, especially at the season when he wrote, for he was in Bermuda only from January to the 5th of May:—

"No, ne'er did the wave in its element steep
An island of lovelier charms;
It blooms in the giant embrace of the deep,
Like Hebe in Hercules' arms.
The blush of your bowers is light to the eye,
And their melody balm to the ear;
But the fiery planet of day is too high,
And the Snow Spirit never comes here."

Cape Sable, Nova Scotia, they are distant 675 nautical miles, south; and 830 miles north from Porto Rico, so that they offer a nearly midway resting place for many flocks of migratory birds that ordinarily fly directly from Nova Scotia to the West Indies. These migratory birds have doubtless brought the seeds of many plants to the islands.

The visible islands form a somewhat hook-shaped group with the concavity on the northern side, facing the great lagoon, and with the main axis running nearly northeast and southwest. The form of the dry land may be more accurately compared to a partially closed

Figure 1.—A Bermuda Residence in winter; at Hamilton.

hand, seen in profile, and with the thumb and nearly approximated finger-tips guarding the entrance to Great Sound and Hamilton Harbor, the latter lying in the axil of the thumb; and the Navy Yard at Ireland Island,* on the tip of the index finger, while the wrist is represented by the eastern part of the group. (See map, fig. 26.)

The dry land of the islands amounts to only about 19½ square miles, or about 12,378 acres. But the extensive submerged reefs and the enclosed lagoons and shoals cover an elliptical area of about 230 square miles, all of which was once dry land. Most

*Ireland Island can best be reached by a small ferry boat that runs across from Hamilton.

of the larger islands are connected by bridges and the great causeway, so that one can drive the entire length of the group, which is about 22 miles, following the road.

There is only one ship-channel by which vessels of any considerable size can pass through the reefs and enter the anchorages of the north side, or the harbor of Hamilton. The harbor of St. George's and Castle Harbor are entered from the south side, but the channels are not deep enough for very large vessels, although the principal one was blasted out, over the bar, to the depth of 16 feet, about 15 years ago, and efforts have recently been made to deepen it to 22 or 24 feet.

The main ship-channel through the reefs to the Navy Yard and to Hamilton Harbor is deep enough for the largest naval vessels, but it is narrow and crooked, and although well buoyed, local pilots are required by the passenger steamers, and the passage is not made at night.

There are two good lighthouses. The largest is the Gibb's Hill Light, near the western end of the main island. It is an iron tower, about 117 feet high, situated on top of a hill 245 feet high, so that the total height is 362 feet. (See figure 2.) The powerful light can

Figure 2.—Gibb's Hill Lighthouse, as seen from the sea, bearing N.E. by North.

be seen at a distance of about 25 miles, from an elevation of 10 feet, or 30 miles from an elevation of 40 feet. (Plate lxv, fig. 2.) This was required on account of the extremely dangerous outer reefs, that often lie from 8 to 10 miles from the land, to the north and west. The other lighthouse is on St. David's Island, at the eastern end of the group, and near the main ship-channel.

It is well known that these islands, which were discovered about 1510, by Juan de Bermudez, were greatly dreaded by the early navigators, and were regarded by some of them as the abode of

demons, on account of the hidden reefs, which made it very dangerous to approach them, even at a great distance. The early writers called them "Devills Ilands;" "Ilands of Devills," and other similar names.*

Sir Walter Raleigh, in 1595, referred to the Bermudas in this way: "The rest of the Indies for calmes and diseases very troublesome, and the Bermudas a hellish sea for thunder and lightning and stormes."

This idea prevailed up to about 1600, when two successive shipwrecks and the escape of the survivors led to more accurate descriptions of the islands and reefs, and almost immediately to their settlement by the English. But it was many years after they were settled before a survey of the main ship-channel was made with sufficient accuracy to allow large vessels to enter with safety. Governor Murray, in 1798, made the first reliable survey and located the ship-channel, and the anchorage inside, which still bears his name.

For about two hundred years, or up to 1815, St. George's was the capital, and its harbor was the principal one in use. There are several other smaller and shallower passages or "cuts" through the outer reefs, some of which are sometimes used by the smaller local vessels, but they are mostly crooked, and dangerous, except in pleasant weather. (See Part II, ch. 14, and map, fig. 26.) Elies Bay, at the western side of Somerset Island, was used as a harbor, to a considerable extent, in former times, the entrance being through Hogcut Channel at the southwestern end of the Main Island.

The water is usually so transparent that the reefs can easily be seen at a distance, even when covered by a considerable depth of water, for they appear like dark masses, against the white shell-sand bottom of the surrounding deeper water. Their dark color is due to the luxuriant growth of brown sea-weeds (mostly *Sargassum*), corals, etc., with which their tops are always covered. Thus the navigation of the inner waters is rendered comparatively easy and safe for small vessels, even where reefs abound. But there are large

* Silvanus Jourdan, one of the party shipwrecked here with Sir George Somers, in 1609, alluded to this superstition as follows:—

"And hereby also, I hope to deliver the world from a foule and generall errour: it being counted of most, that they can be no habitation for Men, but rather given over to Devils and wicked Spirits; whereas indeed wee find them now by experience, to bee as habitable and commodious as most Countries of the same climate and situation; insomuch as if the entrance into them were as easie as the place it selfe is contenting, it had long ere this beene inhabited as well as other Ilands."

areas of the lagoons that are entirely free of reefs. (See map, fig. 26.) These clear, sheltered waters are ideal places for yachting. With a small launch and a native pilot one could spend many delightful days cruising among the innumerable small and picturesque islands, and studying the structure and varied life of the curious reefs and "boilers"; but nearly all of our work was done with row-boats.

The outer reefs, five to eight miles off the northern and western shores, present an almost unbroken barrier to the great seas. They are laid bare in many places at low tide, and other larger areas are then only covered by two or three feet of water, so that the seas break heavily upon them.

After entering the great lagoon, through the main ship-channel, the steamers have to go nearly the whole length of the islands, along the north shore, not far from the land, and then make abrupt turns beyond Spanish Point and through narrow and crooked passages between the numerous small islands, to enter Hamilton Harbor, which is thus admirably protected by nature.

Bermuda is an important British naval and military station, and many of the hills and small islands are surmounted by forts, new or old. Some of the early ones were built before 1622. These are now useless and in ruins, but some of the ruins are very picturesque and curious.

On Ireland Island, nearly opposite Hamilton Harbor, is the navy yard, with the famous great floating dry-dock,* the marine hospital, and other public buildings. More or less of the English naval vessels can always be seen anchored near there, as well as war vessels of other countries.

The appearance of the landscape, along the eastern and northern parts of the islands, as one sees it from the steamer, is far from promising, and is, indeed, apt to be rather disappointing to strangers. For much of the land lying near the north shore was long ago entirely stripped of its originally dense forests of cedar and palmetto, and has become so dry and barren, by the washing away of most of the soil, that nothing will grow there, except scattered

* A much larger new floating dry-dock has been recently built in England to take the place of the old one. It was launched on the Tyne, Feb. 8, 1902. The new one is 545 feet long; 58¼ feet high: 100 feet wide inside, or 126 feet over all, and it can lift a vessel weighing 15,500 tons, or if necessary, 17,500 tons; walls 18 feet thick. It has about twice the capacity of the old one, which was built in 1869. The latter is 381 feet long and 84 feet wide inside, with a lifting power of 8,000 tons.

and stunted cedars, with a few hardy shrubs and wiry grasses. Ledges of gray limestone project through the thin soil, and most of this region looks desolate and barren, as seen from the steamer. Indeed, the northern hillsides of St. George's and the eastern end of the Main Island look as bleak and sterile as the poorest and most barren of the rocky sheep-pastures of New England. The dwarfed Bermuda cedars look much like the red cedars of southern New England in barren situations.

But the early writers all agree that St. George's was at first heavily wooded with cedars and palmettoes, like nearly all the other islands having soil, including even the the small islets of much less elevation, many of which are still thickly covered with cedars. Probably the lack of cedars to stop the salt spray was the most important factor in causing this barrenness. For that purpose the cedar is well adapted, because its dense foliage is not very sensitive to the poisonous action of the salt spray and therefore it makes good windbreaks there. In this respect it is much like our red cedar and pitch-pine, which are often found on small islands and very near the shores. Indeed, many of the smaller Bermuda islets, of which there are more than a hundred, when covered with cedars closely resemble the small wooded islands along the shores of Long Island Sound, as seen in passing. Some of the early settlers mentioned that ships could lie in Castle Harbor moored to the cedar trees on the islands.

Governor Roger Wood, in a letter written in 1633, speaks of sending cedar planks as presents to his friends in England, and mentions that some were 30 and 32 inches wide and 12 to 13 feet long. They were sawed out by hand. No cedar trees now existing there could furnish planks approaching such sizes.

At that period the cedar wood was highly valued in England for choice furniture, on account of its fragrance, hardness, and rich colors, for mahogany was not yet in use.

Legal restrictions were very early imposed (before 1622) against the reckless cutting of the cedars and palmettoes, on the ground that even at that time the land was becoming unproductive, for lack of the shelter given by the trees against the high winds. The poisonous quality of the salt spray and sea-foam that is often driven by the winds far inland over the hillsides, has great effect in keeping more luxuriant vegetation in check, for it kills the foliage of most plants on which it lodges, unless at once washed off by rain.

As the steamer proceeds northwestward towards Hamilton, the hillsides and lowlands become more and more covered with small

forests of dark cedar, with scattered palmettoes intermixed, and with tracts of cultivated land. Many white stone residences can be seen, often partially hidden by the dark cedars, but made conspicuous not only by the natural whiteness of the native limestone, of which they are nearly always built, but also by frequent coatings of whitewash. The roofs are also generally covered with large, thin, overlapping slabs of limestone, coated with cement, so as to shed the rain-water, which is the sole reliance for domestic purposes. All the houses have large water-cisterns.

Springs, and streams of fresh water, do not exist there, nor real wells, though in some low places shallow pools or pits are often excavated in which rain water collects, suitable for cattle, and sometimes for domestic uses, though it generally rests on an understratum of

Figure 8.—Roadside at Fairy Lands near Hamilton, in March, 1901; young Cocoanut Palms and Hibiscus Hedge.

sea-water, a foot or two below, and can be used only when the tide is but partly out, and even then it is slightly brackish in most cases. The water in such "wells" rises and falls with the tide, and if the wells be dug at all below the sea-level, salt water is always reached.

Hamilton, the capital, is a small but interesting town, situated on a high slope facing the harbor. It contains some fine residences and public buildings, and many beautiful gardens filled with tropical trees, shrubs, and flowers, in great variety. The public garden is

very attractive and there are many fine shade trees. Two large modern hotels and several smaller ones, with various boarding houses, accommodate the numerous visitors who remain in Hamilton. There is here a street, Cedar Avenue, with a fine row of the native cedars on each side. The grounds at Mt. Langton, the residence of the governor, are very beautiful and contain many rare trees and flowers.

In the immediate vicinity of Hamilton there are many interesting places to visit, including numerous fine private residences and beautiful gardens and parks. Prospect Hill, the headquarters of the military organization of the islands, is not far away to the eastward. Spanish Point, Clarence Cove, and Fairy Lands are noted places, a short distance northward.

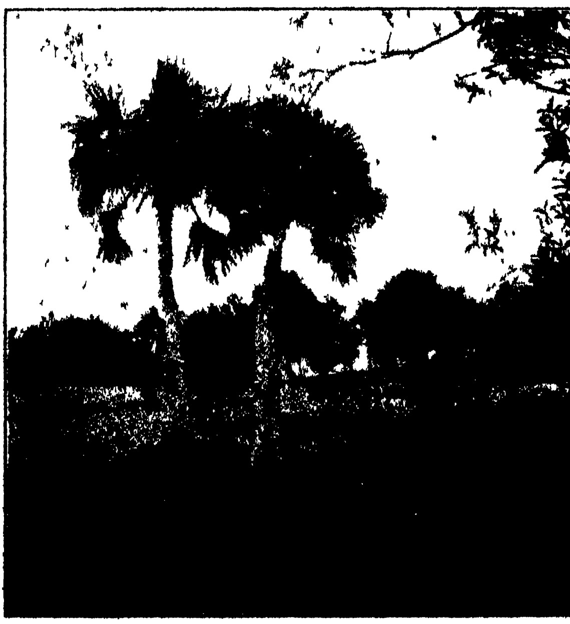

Figure 4.—The native Palmetto.

The native Palmetto is still common, both wild and in cultivation, but is not nearly so abundant as it was originally, nor so large. This tree is peculiar to the Bermudas, though it is very similar to our southern Palmetto in appearance, but it bears sweet, edible berries in large clusters. (See Part III, ch. 86, and figures 39, 40.) In favorable places, in rich, moist soil it grows forty to fifty feet high, but it is more frequently only from ten to fifteen feet. (Figure 4.) It seems to grow rather slowly.

The early settlers depended very largely upon this tree for food, drink, and shelter. Its leaves were used for thatching most of the houses for at least 60 years; its berries were eaten as fruit; its soft growing top was boiled for a vegetable, like cabbage; and its juice and pulp were used to make a fermented intoxicating drink called "bibey" or bibie.

Several foreign palms, including the Date Palm, Cocoanut Palm, and the Royal Palm, are cultivated for ornament, but seldom ripen their fruit. Five tall, straight Royal Palms, standing in a row by the roadside, near Hamilton, and close to the harbor, west of the town, are famous for their graceful forms. (Figure 5, and plate lxvi,

Figure 5.—The Royal Palms near Hamilton.

fig. 2.) The Pride-of-India is one of the most common shade trees. It puts out a profusion of clusters of pink flowers, like small pea-blossoms, in early spring, before the leaves appear. (Fig. 17.)

Both eastward and westward from Hamilton there are three main highways, running lengthwise of the Main Island, which is about 14 miles long, but less than 2 miles wide, in most places. One road is near the middle line of the island; another, which runs along near the northern shore, is called the north road; one, which runs near the south side, is called the south road. These highways generally have very excellent road-beds, with easy grades and a hard, dry surface, composed of the native crushed, soft limestone, which is well

adapted to the making of roads. It is so porous that the heaviest rains very quickly soak into it, and it is seldom dusty. But at the time of my last visit, April, 1901, these roads were considerably out of repair, especially the south road, owing to some very severe storms during the preceding winter.

A drive along either of the three principal roads, on the Main Island, eastward or westward, will at once relieve the visitor of all his impressions of barrenness, derived from the appearance as seen from the steamer, for cultivated land and luxuriant vegetation are seen on all sides. Great numbers and many varieties of foreign tropical trees, shrubs, and flowering plants are abundant along the roadsides and in the gardens. Wherever there is sufficient soil, and

Figure 6.—Banana Patch; a Pawpaw with fruit is near the right side.

especially in the valleys or "sinks," it is highly cultivated. The principal crops are Bermuda onions, early potatoes, and Bermuda lilies, but patches of sweet potatoes, bananas, and various garden vegetables are common. Many unusual fruit trees may also be seen, such as the Orange, Avocado Pear, and most curious of all, the Pawpaw, with its columnar trunk, surmounted by a terminal cluster of large leaves, and sometimes with a cluster of large fruits just below them. It is remarkable for containing a vegetable digestive ferment called papain, capable of digesting meat, etc. (Fig. 6.)

The white Japan or Easter Lily was very extensively cultivated here, a few years ago, for the sake of the bulbs, which were shipped to New York for forcing. It was then not uncommon to see beautiful fields of five to ten acres of fine plants, which were in full bloom in April and May. Sometimes over 100 flowers were formerly produced on one stem. But within a few years the bulbs have been attacked by a fungous disease, which turns the leaves yellow, and dwarfs and spoils the plants, so that the cultivation of this lily for commercial purposes has now been largely abandoned, though some pretty good fields were still to be seen west of Hamilton in 1901. It is to be hoped that some effectual remedy for this disease may yet be found.

Roses of many varieties, and various other flowers, are abundant, and bloom nearly all winter. In many places throughout the islands, tall hedges of Oleanders, both red and white, border the roads on both sides for long distances, and when in flower, in the spring and early summer, they are very beautiful and fragrant.

There is an excellent road for driving, or cycling, running through the central part of the Main Island and Somerset Island, and from this a short cross road leads to the famous Gibb's Hill Lighthouse, from which a very extensive bird's-eye view of the whole group of islands can be obtained. (Plate lxvi, fig. 1.)

That portion of the Main Island that lies west of Hamilton contains, apparently, the most fertile and productive lands on the islands, and owing to the considerable breadth of land in most places and its sheltered position, by which it is partly protected from the cold winds, the climate seems to be warmer here than on the eastern and more exposed parts of the islands. This may also be due largely to the greater number of cedars and other trees left growing as windbreaks Owing to these several causes the vegetation in this region is particularly luxuriant and pleasing, especially in Paget and Warwick parishes.* Somerset Island is also fertile and well cultivated. The best lily fields were seen here in 1901.

* There are many places in these western parts of the islands to which some of Thomas Moore's graceful poetical descriptions would now apply, even better than to St. George's, where they were written :—

> "Could you but view the scenery fair,
> That now beneath my window lies,
> You'd think, that nature lavished there
> Her purest wave, her softest skies,
> To make a heaven for love to sigh in,
> For bards to live and saints to die in."

In several places there are thick clusters of tall, graceful bamboos, which sometimes overarch the roads. One of the finest of these groups is situated close by the house occupied by the Empress Eugenie, while she was living here several years ago. This is on a cross road a short distance west of Hamilton. (See plate lxvii.)

Near Elbow Bay, on the south shore, there are extensive modern sand-dunes, only very recently stopped in their destructive advance over the fertile soil, which they had kept up for more than a century. These are of special interest to many persons, but they are still very barren, and are only occupied by sage-bush and other sand-loving plants. In their progress they buried groves of cedars and one dwelling house. (See under Geology.)

Hungry Bay, also on the south shore, with its dense mangrove swamp, is a weird and solitary place, but very interesting to the naturalist.

Figure 7.—Cathedral Rocks on Somerset Island. This appears to be the ruins of an ancient cavern, partly broken down and dissected by the sea; the roof has partly fallen down. The columns are hardened by infiltration of calcite and roughly pitted.

Elies Harbor, or Bay, on the west side of Somerset Island, is a beautiful body of clear, brightly tinted water, with a white sand bottom. Formerly it was a port of some importance.

On the point of land separating Elies Bay from "The Scaur," which is a smaller and shallower bay to the south, are situated the

remarkable "Cathedral Rocks" or "Old Church Rocks," which have been carved and worn by the sea into the forms of curious columns and arches, resembling some ancient ruined temple. But the columns are not so high as they seem to be in the photographs. (See fig. 7, and plates lxxxviii, lxxxix, and Geology.)

Owing to abundant moisture in the atmosphere, and frequent clouds, the sunsets are often exceedingly brilliant, and the sunset colors of the sky, reflected from the bright waves, add greatly to the brilliancy of the color effects.

Figure 8.—The Bermuda Cardinal Bird, from life.

Another curious phenomenon may often be seen in spring and summer, when the white Tropic-birds can be almost constantly seen in many parts of the islands, flying over the water and uttering their loud cries. Their two long central tail feathers stream gracefully out behind them as they fly. On bright days the white under surfaces of their wings and bodies appear to have a *clear, pale green color*, due to the light reflected upward from the white sand of the

bottom through the green sea-water. These birds nest in holes in the cliffs and are protected by law. They migrate to the south for the winter, and return in March. (See plate lxxii.)

Many small birds, which are numerous and tame, may be seen along the roadsides. Although there are only about twelve species of birds native to the islands, or which breed there, the numbers of individuals of several of them are large. The best singers of the native resident species are the Cardinal Bird (fig. 8), the Bluebird and the White-eyed Vireo (Part VI); but the Mocking Bird, English Goldfinch, American Goldfinch, the Wheatear, and other foreign birds have recently been introduced and are now naturalized there. (See Part III, ch. 34.)

The Catbird is resident and abundant. It is as tame and audacious as with us (see Part VI). The English sparrow was introduced some years ago and is very abundant. The Bluebird is a larger and brighter variety than our northern one. (Fig. 9.) The same is true

Figure 9.—The Bermuda Bluebird, from life.

of the Cardinal Bird, of which the male is redder than the common American variety, and has a brighter red crest. (See Part VI.) The song of the Cardinal Bird is varied and agreeable, and it is said to change according to the season. The little Ground Dove is very tame and is often seen along the roadsides, or feeding in the roads. (Fig. 10.) The American Quail or Bobwhite is also now common, but the present race was introduced in recent times, about 1859, it

is said, by Mr. R. Darrell, the original ones having been exterminated about 1840. Possibly the original ones had been introduced at an earlier period, by the settlers. In the spring and fall a large number of other American birds come to the islands to rest for a

Figure 10.—The Ground Dove, from life.

short time during their migrations, and some may remain through the winter. Some of these come regularly, every season; others only occasionally or accidentally. Among them are various ducks and shore birds, but they are not usually numerous.

Going eastward from Hamilton, in pleasant weather, the north road is most delightful, for it affords numerous fine views of the adjacent waters, which here are clear and sparkling, and have most surprising tints of sapphire-blue and bright turquoise-blue, changing in the distance to deep indigo-blue or ultramarine, while in shallow water, nearer the shore, the color is commonly emerald-green or beryl-green, constantly varying in tints according to the nature of the bottom, the state of the sky, and the agitation of the surface.

On occasions when a strong northerly or easterly wind is blowing, the north road, eastward of Hamilton, is to be avoided, because it is much exposed to the wind, and in many places the salt spray is apt to be blown across it at such times. The two other roads are much more sheltered from the wind, and have special attractions of their own. The hard, smooth road-beds, composed of the crushed porous limestone, are all well adapted to the cyclists, and many of these are constantly met on the roads, and especially on the north road.

A short distance north of Hamilton, on the shore, near the north road, there is a plaçe still called the "Ducking-stool." It is said to have been the site of that ancient and peculiar instrument for the punishment of gossiping or scolding women, who led "scandalous lives." It was also used in England and America, at that time.*

Owing to the softness of the limestone, many deep cuts have been made through this stone, which forms all the hills. The rock is divided vertically into blocks by deep, narrow channels, cut by means of heavy steel chisels, about two inches wide, mounted on long handles. These great blocks are then dislodged, and if sound enough are cut up into regular rectangular blocks, suitable for the walls of houses or other masonry, by means of ordinary cross-cut wood saws. It is said to saw about as readily as soft wood, when first quarried, but it rapidly hardens at the surface when exposed to the weather for a few months. (Fig. 11.)

As a result of this mode of quarrying out a road-cutting, the sides of the cuts are always steep, often nearly perpendicular, and they afford excellent sections for the geologist. Everywhere they show the irregular, abruptly shifting stratification, often with the layers inclined at high angles, characteristic of wind-drifted or sand-dune formations. This plainly proves that all these hills are only consolidated sand-dunes, made of shell-sand blown from the ancient sea-beaches. Several of the deepest cuts are near Hamilton, which is a hilly region. (Fig. 12.)

Various vines and herbaceous plants have taken root in the crevices of the older cuttings and help to conceal their angular and artificial

* It seems, from the following record, that a "stool" was not found necessary for administering the punishment in the early years of the settlement.

"At the Assizes, 18th June, 1667." "Susana Bayley, wife of John Bayley of Deven: Tribe, presented for that shee the said Susana is a person of scandalous life, and found by her conversation to promote dissention in the neighbourhood. Whereuppon the said Susana was found guilty by a Jury of 12 sworne men, uppon the 27th day of June '67. And was censured by the unanimous Vote of the Court, to be forthwith ducked with three ducks. Which said Censure was accordingly performed from aboard a vessells yards arme lying at the Bridge, the sayd day." Five ducks were often given to women.

How many ducking stools were subsequently erected does not appear, but there is recorded an order of the Council of Sandys Tribe for the erection of a "duckingstoole" March 25, 1672. It was also ordered that Miles Rivers should either pay for that ducking stool, or else his wife Mary should be ducked "when the stoole is erected." The Sheriff had complained "that she did abuse him with her tongue in ye execution of his office." The records do not show which horn of the dilemma was chosen.

appearance. Among these, the native Maiden-hair Fern, peculiar to the Bermudas, is the most delicate and graceful. (Fig. 33.)

Several species of Cactus or "prickly pear" (*Opuntia*) grow commonly on the walls and rocks by the roadsides. They bear large yellow flowers, in their season, and dark red edible fruits.

The singular Life Plant (*Bryophyllum*) covers the barren places, rocks, and walls along the roads with its large fleshy leaves, and in the spring it sends up tall spikes of pink bell-shaped flowers. This is the same plant that is cultivated with us as a house-plant, partly

Figure 11.—Quarrying Limestone with chisels and saws

on account of its singular power of putting forth several complete young plants from the edges of a cut leaf, when laid on the surface of the earth. It is very much at home in Bermuda and spreads rapidly. It serves well to cover unsightly or barren places, for it appears to be able to grow on almost bare rocks. (Plate lxxiv, fig. 2.)

The underbrush along the roads is composed largely of the naturalized shrubby Lantanas, which bear a profusion of bright orange or red flowers. It is here called "Sage Bush," and in some places it has become a troublesome weed, as in many tropical countries, but it is very useful in binding the drifting sands.

Along the north road, in many places where it approaches closely to the shore and is exposed to violent winds and salt spray, tall hedges of Tamarisk, called "Spruce" by the Bermudians, have been planted. This shrub grows here to large size. Many of the older ones, having been many times broken and bent by the storms, have acquired a weather-beaten and picturesque appearance. Its delicate, heath-like foliage stands the poisonous action of salt-water spray very well. In May and June it puts out large clusters of small, pink, bell-shaped flowers, much like those of a heath. It is a native of southern Europe.

Figure 12.—Road Cutting near Hamilton.

In other places can be seen hedges of Century-plants, or *Agave*, of several kinds. Some of these flower freely here in early spring, sending up tall branching stalks, sometimes 10 to 15 feet high, covered with a profusion of yellow flowers. In many places there are hedges of the scarlet-flowered *Hibiscus*, which is very showy when in flower. Hedges of the Pomegranate; Spanish Bayonets (*Yucca*); Cycads; Pepper-bushes; Snuff-bushes; Galba, with its glossy leaves, and other unusual hedge-plants form hedges in certain places.

Traveling eastward by the north road, one passes through Flatts Village, where the road crosses the inlet to Harrington Sound. This sound is a considerable body of sea-water, completely land-locked, except for this small channel, but the sound itself can best be seen from the middle and south roads.

From the bridge across the shallow but rapid tidal stream, one can see, beneath the clear water, a great variety of living sea-weeds, sponges, and other organisms, of various bright colors. Among these the most conspicuous are large masses of a bright red, orange, or scarlet sponge, which grows in many different shapes, and varies much in color.

Several fine residences and beautiful grounds are situated in the village and near it. Many visitors, including several scientific parties, have made it their headquarters.* There are here, and near-by, several good boarding houses, but no large hotel.

In the interesting grounds at "Wistowe," the residence of the late Hon. C. M. Allen, formerly United States Consul, there is a stone basin for fishes. It is fed by a tidal current of water flowing through a trench cut from the inlet to Harrington Sound. A fine collection of bright-colored fishes can usually be seen here. Among those noticed in 1901 were some large green and yellow Angel-fishes; the brilliant Doncella; a large Blue Parrot-fish; the Blue Oldwife or "Turbot," and others of interest.

By the roadside, at this village, there is a very large Mahogany tree, which is the only large one on the islands. Not far away there is also a very large India-rubber tree, and in several of the grounds are numerous good specimens of Palms and the native Palmetto, with the Pawpaw and many other interesting trees and shrubs.

The mouth of the inlet here was at one time, many years ago, a harbor of some importance, with docks and warehouses, but it is now so silted up that it is only deep enough for boats. Indeed, it has always been liable to become obstructed by sand bars, on account of its strong tidal currents and the bottom of shifting sands.

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* Flatts Village is advantageously situated in many respects for this purpose, as well as for the pleasure seekers. Among other naturalists, Prof. Wm. North Rice and the late Mr. G. Brown Goode, who subsequently was at the head of the U. S. National Museum, and also for a short time was U. S. Commissioner of Fish and Fisheries, made extensive collections here in 1876–7. Mr. Goode published several papers on the Fishes of Bermuda. Professor Heilprin, of Philadelphia, with one of his parties, also chose this place in 1888.

The best localities for obtaining the very singular fish-like creature called the Lancelet or Amphioxus are on the shallow sand-bars of this inlet.

As far back as 1620, there is a record of one Thomas Emmet having been paid 50 lbs. of tobacco for digging out the mouth of the channel. At that time, and long after, tobacco was the regular currency of the colonists.

Not far beyond Flatts Village the road passes Shelly Bay, named for Mr. Henry Shelly, one of the party shipwrecked on the islands with Sir George Somers, in 1609, by whom it was discovered. It abounded with fish at that time. It has a broad crescent-shaped beach of white sand, but the bay itself is very shallow and full of rocky reefs. In bright weather its waters are beautifully tinted with emerald green. It has considerable scientific interest, because long after its discovery it became obstructed with sand-dunes which were eventually covered with vegetation. But about 1807, these sand-dunes were rapidly swept away again by the wind and sea, thus quite changing its form and size (see Physiography and plate lxviii).

Going farther eastward, the north road passes through Bailey's Bay Village, which has been a favorite place for several scientific parties and many other visitors.*

At this place there is a very large and handsome Tamarind tree, about six feet in diameter, by the residence of Doctor T. A. Outerbridge. In the yard of Mr. J. D. Seon, there is a Cycad of unusually large size, said to be over 60 years old. This village has two small bathing beaches of white shell-sand. Such beaches are but few on the north side of the islands.

In the shore cliffs, a little east of Bailey's Bay, there are two grottoes of considerable size, side by side, which can only be entered at low tide, and by the aid of a boat.

Several roads diverge from Bailey's Bay, and connect around Harrington Sound with all the roads to Hamilton. Another goes east to the long causeway and St. George's.

Traveling eastward from Hamilton, the middle and south roads unite at the western end of Harrington Sound into a road that skirts its entire southern and eastern shores. This road has many attractive features, but is somewhat hilly. It affords many beautiful views of Harrington Sound, with its islets and headlands. This sound is a fine expanse of pure transparent water, and is as completely landlocked and surrounded by hills as a lake. It has but very little

* My party of 1898 had its headquarters here at "Seaward," the home of Mr. J. D. Seon. We found the situation, owing to its central position, a very favorable one for visiting the islands and reefs of Bailey's Bay, Castle Harbor, and Harrington Sound.

tide, usually 6 to 8 inches, and contains several small islets, some of which are inhabited; others are wooded and unoccupied. Trunk Island has a stone residence and pleasant grounds with palmettoes and other shade trees upon it. Its clear waters abound in marine

Figure 18.—Harrington Sound and small Islets.

life and its cavernous cliffs and shell-sand beaches afford some excellent places for zoölogical collecting, especially since collecting can be done here with a boat when it is too windy to do anything of the kind on the other shores. (Plate lxxi.)

Near the western end of this sound, and close by the roadside, is "Devils Hole," which is a natural fish-pond connected by subterranean crevices with the sea. It was formed by the falling in of the roof of a cavern. It has been enclosed by a wall and stocked with hundreds of fishes, mostly large "Hamlets" or Hamlet Groupers. With these are some Green Angel-fishes, Oldwives or "Turbots"; and a few other kinds. When we visited the place, it also contained several green Sea-turtles.

It is a sort of gigantic natural aquarium, and is well worth a visit. The fishes are fed so often by visitors that even the large Groupers, some of them a yard long, will take bread and other food from one's hands, but caution is necessary lest they take the fingers also. When food is thrown into the water there is a wonderful scene of wild commotion, and a great display of wide-open red mouths.

On the south side of the island, not far from here, there is an extensive beach of white shell-sand, on which the breakers, in southerly winds, beat with great force. The loose sand from the beach, which

has been drifted from the shore by high winds, has formed hills or dunes of white sand that extend a considerable distance from the shore, at Tucker's Town, burying the once fertile soil. This has been going on here for about a hundred and twenty-five years. The loose sand of the dunes has not yet been stayed in its destructive progress by the binding roots of various shrubs and grasses that will grow in such soil, though the area of loose sand has already been much diminished by them. (Plates lxxv, lxxvi, and see Physiography, ch. 10.)

These are now the only important active, or moving, sand-dunes on the islands, though there were other even more extensive ones a few years ago, especially near Elbow Bay, all of which have now been stayed by the vegetation. At the latter place they formerly buried, in their irresistible progress, a dwelling, all except the chimney, and also groves of cedars.

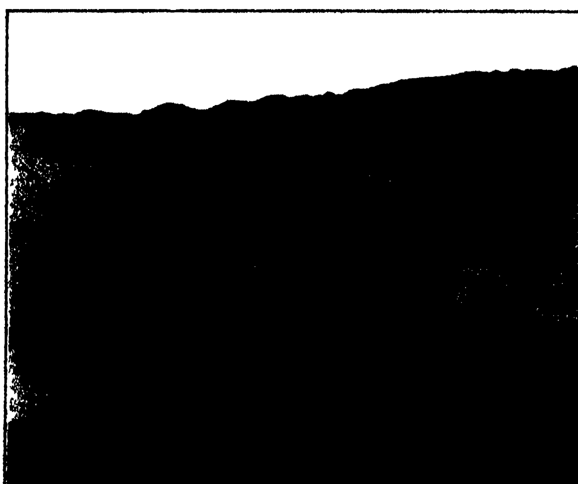

Figure 14.—Lion Rock and Harrington Sound.

At a rocky promontory, interrupting the beach, there is a very interesting rock-sculpture, consisting of two large, well formed arches, side by side, and separated by a massive central pillar of limestone. (Plate lxxxvii.)

The south road also passes close by "Lion Rock," a curious rock-sculpture, carved by the waves, and so named from its form. (Figure 14.)

Shark's Hole, nearby, is a large natural archway or tunnel, leading far under the cliff, with water in it deep enough for a large boat to enter for a considerable distance. Corals, sponges, and seaweeds may be seen growing on the bottom in the clear water, and schools of large Sea Lawyers or Gray Snappers and other fishes are often to be seen swimming among the broken rocks in plain view, but these lawyers are too sly and intelligent to be taken with a hook. (Plate lxxiii.)

Near Shark's Hole the road passes Paynter's Vale, a very old estate, once highly cultivated, but now much neglected. Many unusual shrubs and trees grow half wild upon it, including wild coffee-trees, citrons, lemons, and many others. In front of the house is the first Fiddle-wood tree planted in Bermuda, and it is said to be the parent of all the trees of that kind on the islands. It was set out about 73 years ago, and is now about 5 feet in diameter. It lost some of its larger branches in the hurricane of September, 1899, but is still a large tree. This species spreads rapidly, both by its seeds and roots, and is now probably the most abundant deciduous tree on the island. Its bright green foliage contrasts finely with the dark green of the cedar. (Plate lxx.)

Not far away, the road passes near the Peniston Cave (plate xciii), which has not yet been opened to the public, and is rather difficult to explore. It is, perhaps, the most beautiful cave now known on the islands, on account of the great number of stalactites and the variety of forms that they have taken, and also because of their nearly pure white color. This is due to the fact that in this cave torches and bonfires have not been allowed to coat over the surfaces with soot, which has been done to a deplorable extent in many of the other caves. This should have been prohibited long ago. (See Geology.)

It belongs to Mr. W. S. O. Peniston, the proprietor of the Harrington House,* close by. It is to be hoped that he will soon improve the entrance and make it readily accessible to visitors.

A short distance farther north the road passes near the famous Walsingham place, which has some interesting historic associations, and it is also an interesting locality for the geologist and naturalist.

The picturesque old stone house, not now occupied, is situated

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* This boarding house was our headquarters in 1901. We found this place an excellent one for our purposes. It is very near Harrington Sound on one side and Castle Harbor on the other.

close to the shore of Walsingham Bay.* (Fig. 15.) It is considerably out of repair and some of the outbuildings are in ruins. It is one of the oldest houses on the islands, for it is said to have been built about 1670–80, but it has been considerably altered and repaired within 50 years. It is pointed out to visitors as the house of the poet, Thomas Moore, who really resided at St. George's for about four months, from January to May, 1804. He had been appointed

Figure 15.—Walsingham ; Mangrove Trees on the left side

to an official position there, which did not prove satisfactory to him, so he delegated his duties to a deputy and returned home, after visiting the United States and Canada. He may have been an occasional or a frequent guest at the Walsingham House, for the

* This Bay was so named in 1609, in honor of Mr. Walsingham, coxswain of the "Sea Venture," who discovered it. It is related by Strachy that when the vessel, which the shipwrecked crew had built, finally set sail for Virginia, she got aground on one of the reefs at the entrance of St. George's Harbor, causing great dismay, but Mr. Walsingham soon got her clear of the reef. "When shee strucke upon the Rocke, the Cock-swayne, one Walsingham, beeing in the Boate, with a quicke spirit (when wee were all amazed, and our hearts failed) did give way stoutly, and so by Gods goodnesse hee led it out at three fadome, and three fadome and a half water. The wind served us easily all that day and the next (God be ever prayed for it) to the no little joy of us all, we got cleere of the Ilands."

owner, at that time, was very hospitable, but there is no evidence that he ever remained there even over night. The room that is called "Tom Moore's room" was really the dining room, as I was assured by persons who had resided in the house before it was altered.*

On this estate, farther back from the shore, in a grassy glade near the caves, is the famous old Calabash tree under which Moore is said to have composed some of his Bermuda poems, and to which he certainly refers in his notes and diary.

In his notes to his poems he makes the following allusion to this tree :—

"How truly politic it is in a poet to connect his verse with well-known and interesting localities,—to wed his song to scenes already invested with fame, and thus lend it a chance of sharing a charm which encircles them,—I have myself, in more than one instance, very agreeably experienced. Among the memorials of this description, which, as I learn with pleasure and pride, still keep me remembered in some of those beautiful regions of the West which I visited, I shall mention but one slight instance, as showing how potently the Genius of the Place may lend to song a life and imperishableness to which, in itself, it boasts no claim or pretension. The following lines in one of my Bermuda poems :

> 'Twas thus by the side of the Calabash tree,
> With a few who could feel and remember like me'

still live in memory, I am told, on those fairy shores, connecting my name with the noble old tree, which, I believe, still adorns it. One of the few treasures (of any kind) I possess is a goblet formed of one of the fruit-shells of this remarkable tree, which was brought from Bermuda a few years since by Mr. Dudley Costello, and which that gentleman very kindly presented to me."†

* An old lady, only recently living in Bermuda, used to say that she could well remember that when she was a young girl, living nearby, she used to see Tom Moore rowing in his skiff, and coming to Walsingham, and that he was a handsome young fellow with curly, golden hair, "just the color of a sovereign." This agrees well with contemporary descriptions of him.

† In his published diary the following occurs:—"20th (March, 1834). A beautiful present from Mr Costello of a cup formed out of the calabash nut, which he brought some years ago for me from Bermuda. The cup very handsomely and tastefully mounted, and Bessie all delight with it."

The verses referring particularly to the Calabash tree are as follows, in the later editions of his poems :—

> "'Twas thus in the shade of the Calabash-tree,
> With a few who could feel and remember like me,

Many other interesting trees and shrubs, some of them very rare, and not to be found elsewhere on the islands, are found in the Walsingham woods, around the caves and among the rugged ledges. This tract, unlike most parts of the islands, appears never to have been entirely cleared of its original natural growth of vegetation, and many foreign species were also early introduced here. About 25 species of native plants are nearly or quite restricted to this district, including several ferns. The only native Yellow-wood tree now known on the islands stands in this district, although it was common at the time of the first settlements, and yielded a valuable timber. (See Part III, Deforesting, ch. 26, c.)

By the side of the house there is a good sized Date Palm. Coffee trees, Olives, Orange trees, and Lemon trees are common, growing wild in the woods. Near one of the roads there is a wonderful wild tangle of the fragrant white Jasmine, which clambers over the ledges and drapes the highest cedars to their very tops.

On this estate are several large caverns and grottoes, hung with huge stalactites. (Plates xc–xcii, see Geology.) One of these, which has two entrances, has an earth floor, but the others have the floor covered with a considerable depth of clear sea-water in which the stalactites are beautifully reflected, when illuminated. One of them, near the sea, contains fishes.

Near the caves there are some natural fish ponds, due to fallen caverns, and filled with very clear water, in which at the time of our visit there were many beautiful fishes. A much larger and deeper pond, near the house and mostly concealed by trees, contained several large Sea-turtles, apparently living there in great comfort, and with plenty of room for swimming and diving. Those that came well into view were Green turtles.

The long causeway leading from the Main Island to St. George's is of considerable interest. From it can be seen excellent views of Castle Harbor with its small outlying islands,—Castle Island, Coopers Island, Charles Island, etc., in the distance, and the thickly wooded

The charm that, to sweeten my goblet, I threw
With a sigh to the past and a blessing on you."

* * * * *

"Last night when we came from the Calabash-tree,
When my limbs were at rest and my spirit was free,
The glow of the grape and the dreams of the day
Set the magical springs of my fancy in play,
And oh, such a vision as haunted me then
I would slumber for ages to witness again."

hills of the Main Island nearer at hand. Castle Harbor is a beautiful body of clear water, four to five miles across, containing numerous coral reefs, which afford very favorable places for studying the reefs and collecting specimens of many kinds. Living Brain Corals and some other kinds can be seen from the causeway, in shallow water.

But the causeway itself has an interesting history from a scientific point of view. It was completed in 1871, at the cost of £28,000. It is about a mile and a half long and was originally almost entirely of stone masonry, with several archways at different points and a swing-bridge of iron, 123 feet long, near the eastern end.

During the great West Indian hurricane of September 12, 1899, it was almost entirely demolished during the night. No one, so far as known, saw it go down. It was soon afterwards rebuilt, but much of the new work is of timber. A naturalist would reasonably expect that the timbers, when below half tide, will be eaten up by the Teredos or "Shipworms" in a few years, for they are sufficiently common at the Bermudas.

It is said that the great seas and high tide that destroyed this causeway came in from the southwest, through the rather narrow channel between the islands that guard Castle Harbor on the south side, and passed entirely across this shallow bay before reaching the masonry of the causeway. If so, one can hardly imagine the size and violence of the seas that dashed against the fully exposed cliffs of the south shore during that fearful night. It is certain that considerable changes were effected there at that time, and much loose material was washed away in many places.

Great damage was done, at the same time, to the wharves and buildings at St. George's, and to the causeway and other naval works at Ireland Island. Many large trees were blown down all over the islands, numerous boats were destroyed, and a large part of the buildings were more or less damaged, many were unroofed, and some blown down. No lives were lost, as there must have been had, not the dwellings been built with thick stone walls.

No such severe storm had occurred here for just sixty years, but the great hurricane of Sept. 11, 1839, was very similar.

The causeway is interrupted, toward the eastern end, by Long Bird Island, which owes its name to the immense number of "Egg-birds" or Terns that bred on it when the Bermudas were first settled. These birds and their eggs and those of the Cahow were among the principal sources of food supply for the earliest settlers, and on one

occasion, at least, they saved a large number of the colonists from starvation (1615). But the birds were killed and robbed so recklessly and cruelly that they were soon exterminated and no relics of them remain now, except in the name of the island. Capt. John Smith, in his General History of Virginia, ed. of 1629, states that the egg-birds and cahows were all gone, even at that time.

The sand flats that border this island on both sides are, at low-tide, excellent localities for collecting numerous varieties of marine animals that inhabit such sandy places in shallow water. A few Mangroves and Blackjack trees grow here along the shore, close to the road. (See plate lxxiv, fig. 1.)

St. George's is a quaint old town with many very narrow and crooked streets and odd-looking buildings, many of them very old. It is said that the narrowness of the streets (fig. 16) is due to their having been laid out before horses and carts were introduced here. During the first fifty years of the colony, all the highways were required to be only 12 feet wide for the same reason. The old St. George Hotel, facing the square, is said to be one of the oldest buildings on the islands. Its great beams of hewn cedar, some of them about 14 inches square, are still sound, though the building is supposed to be over 200 years old.

Figure 16.—Ancient Narrow Street in St. George's.

It looks much more like some old town of southern Europe than like anything American. It was the first place settled on the islands, in 1612, and was the capital for about 200 years. It is partly situated along the water front of a commodious harbor and

partly on the slope of a rather steep, rocky hillside that overlooks the harbor. From this hill there is a fine view of the surrounding islands and waters. On the crest of the hill is situated Fort St. George, with the barracks and other military buildings. Several other forts, some of them of antiquated construction and now of little or no use in war, overlook the entrance of the harbor. But some modern batteries have also been built near the town.

St. George's is rather notorious for the extensive business in blockade-running that centered there during the late civil war in this country. In this business it was probably not excelled by any other port, unless Nassau. Fortunes were rapidly made and lost at that time, and business was very lively. But it does not appear that this business resulted in any lasting benefit to the town. Indeed, it is said by many that it was, on the whole, a great detriment, because it disturbed or destroyed all normal kinds of business, distorted values, and demoralized those connected with it.

At present its commerce is of small amount, for Hamilton has become the principal port. But it is an interesting place to visit. It has a very creditable public garden, near which may be seen the tablet erected in 1876, by Governor Lefroy, in memory of Sir George Somers, who died at St. George's, Nov. 9, 1610, and whose heart was buried there, at his request.

There are many other places of historical interest in St. George's. But the "Alley of Limes," immortalized by Thomas Moore, no longer exists.*

The house of "Nea,"† to whom his "Odes to Nea" were dedi-

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* His reference to it is as follows:

> "And thou—when, at dawn, thou shalt happen to roam
> Through the lime-covered alley that leads to thy home,
> Where oft, when the dance and the revel were done,
> And the stars were beginning to fade in the sun,
> I have led thee along, and have told by the way
> What my heart all the night had been burning to say,—
> Oh! think of the past—give a sigh to those times,
> And a blessing for me to that alley of limes."

† "Nea" was Miss Hesthea Louisa Tucker, who afterwards married Wm. Tucker. She died in December, 1817, aged 81, and left several children. Some of her descendants still live in Bermuda. Two of her granddaughters were named Nea. It is said that she was already betrothed to Mr. Tucker at the time when Moore's verses were written. This might also be inferred from some of his verses, especially his farewell lines:

> "Well—peace to thy heart, though another's it be,
> And health to that cheek, though it bloom not for me!"

cated, is still standing, but all in ruins. The nearby house of the Admiral, where Moore was entertained, has disappeared, though its foundations remain.

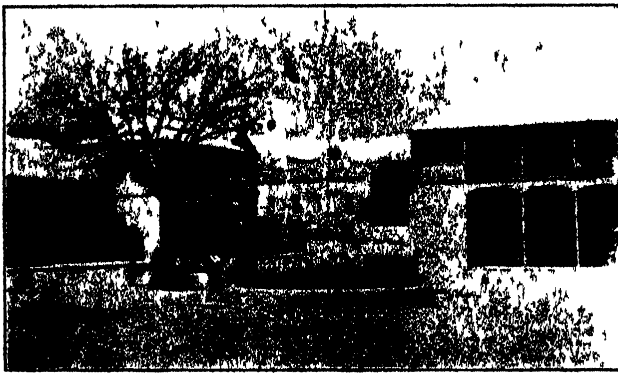

Figure 17.—St. George's, the Public Square. The old St. George's Hotel is at the right; the tree is a "Pride of India," without its foliage, in March. Phot. 1901.

It is not known where Moore had his living rooms, but it was certainly in St. George's,—not at Walsingham, as many suppose. The lines of one of his poems,* in which he refers to the nearby boats and barks as seen from his room, would well have applied to many places in St. George's, but not to Walsingham, as also the statement, in a letter to his mother, that he could plainly see "six islands" from his window. He expressly states that the admiral had invited him to sit at his table.

* The following are the descriptive verses referred to:—

"Close to my wooded bank below,
In glassy calm the waters sleep,
And to the sunbeam proudly show
The coral rocks they love to steep.
The fainting breeze of morning fails,
The drowsy boat moves slowly past,
And I can almost touch its sails
As loose they flap around the mast.
The noontide sun a splendor pours
That lights up all its leafy shores,
While his own heaven, its clouds and beams,
So pictured in the waters lie,
That each small bark, in passing, seems
To float along a burning sky."

The harbor of St. George's is a beautiful sheet of water, nearly landlocked by the several islands that surround it. There are three channels that enter it from the southeast, and one from the north, through the swing-bridge of the causeway. But neither channel is sufficiently deep to admit very large vessels, though the main channel was deepened to 16 feet many years ago (about 1846). The question of further deepening the entrance of the main channel, at the bar, has been discussed for several years, and probably this will eventually be done.

It was the harbor of St. George's that Thomas Moore referred to in some of his finest descriptive verses, as well as in the notes appended to his poems. But his poetical descriptions would now apply equally well or better to various other localities in the Bermudas. At the time of his residence here (1804), Hamilton had not become the capital and was a place of such secondary importance that he did not even mention it at all, though the islets covered with cedars are much more numerous and beautiful in its harbor.

In the notes to one of his poems, referring to St. George's harbor,* he gives the following graceful description :

"Nothing can be more romantic than the little harbor of St. George's. The number of beautiful islets, the singular clearness of the water, and the animated play of the graceful little boats, gliding forever between the islands, and seeming to sail from one cedar-grove into another, formed altogether as lovely a miniature of nature's beauties as can well be imagined."

His description indicates that the small islands near St. George's were, in 1804, more thickly covered with cedars than at present.

* The following are the verses referred to :

"Bright rose the morning, every wave was still,
When the first perfume of a cedar hill
Sweetly awaked us, and, with smiling charms,
The fairy harbor woo'd us to its arms.
Gently we stole, before the whispering wind,
Through plantain shades, that round, like awnings twined,
And kist on either side the wanton sails,
Breathing our welcome to these vernal vales ;
While, far reflected o'er the wave serene,
Each wooded island shed so soft a green
That the enamoured keel, with whispering play,
Through liquid herbage seemed to steal its way.
Never did weary bark more gladly glide,
Or rest its anchor in a lovelier tide !"

Paget's Island and Smith's Island, which form the southeast boundary of the harbor, were both fortified in the early years of the settlement, by Governors Moore, Tucker, and Butler (1612–1621), and Governor Woodhouse, in 1626, built a new fort on Paget's Island, near the present Fort Cunningham.

Governor Tucker, though a rather energetic man in some directions, apparently had about as little knowledge of, or respect for, the ordinary rules and customs in the construction of forts, as in the administration of the civil laws. He was accused of having greatly exceeded his authority and of violating the English laws, in some of the trials. His officers and juries were evidently so cowed by fear for their own safety that they did about anything he wished.

Many persons, in his time, were sentenced to be hanged for very trivial crimes, though some, after being sentenced and taken to the gallows, were reprieved by the governor "in his great mercye," as the records say, but they then remained as "condemned persons," and in some cases were illegally sentenced to remain as "slaves to the company." Perhaps he was well aware that some of these persons richly deserved hanging for other crimes.

Governor Butler (1619) gave the following account of one of these trials:—

"But the third man (whose name was Paul Deane) escaped not so well, for being endicted for the stealeinge of a peece of cheese, he was arraigned and condemned, and therupon craveinge the benefitt of his booke (the prize of the stolne goodes being valued at twenty pence), it was answered him by the Governours owne mouth (very unwarrantably) that he would allowe noe booke in a plantation; so that therupon being sentenced, he was hanged the next daye; and it was secretly muttered, as if the Governour had owed him some secrett spleene, and the rather because at his arringement, when the stolen cheese was at the first valued under twelve pence,* he caused it (in a fury) to be prized at twenty pence."

Some of the people, who afterwards sent a complaint about this to the Company, did not object to the hanging, but only complained of the illegal character of the trial. The laws of England were considered strictly applicable to Bermuda at that time.

Governor Butler, who was more skilled in constructing public

* It appears to have been a regular practice, in those times, for the owners of stolen articles to undervalue them, in order to avoid the application of capital punishment. It would seem that the complainant had a right to do so by usage, if not by law. Stealing anything of the value of 20[d] or more was a capital crime at that time.

works, enlarged and repaired, in 1620, the fort built by Governor Tucker on Paget's Island and called Paget's Fort. He made the following criticism of the original structure :—

"Some 8 or 10 men are appointed to cutt out a plattforme at Pagett's Fort, the which (as the worck itselfe sheweth to this daye, and ever will doe in despight of all amends) proved so unfashionable, uncapable, and ill layd out, that it is absolutely the most uncerviceable and unsightlest peece in that kind of the whole ilands; and yet by situation and for use, requireinge as much or more protection than any other whatsoever." Elsewhere, he stated that at high tides and in storms it was partly under water.

Across the harbor from St. George's lies St. David's Island, only accessible by boat. This is a large island, irregular in form, with several hills over one hundred feet high, and with a very broken coast line, enclosing several bays and coves. It is the principal seat of the sea-turtle fishery, which is carried on only in summer, from June to September.

The turtles are taken by the skillful use of very large and strong seines, eighty to eighty-five fathoms long and about six to seven fathoms wide. About eight boats, with two men in each, engage in this fishery. The number caught here is quite variable, say from fifty to one hundred and fifty Green Turtles each season, besides a few Hawksbills. The average weight is, perhaps, about fifty pounds; occasionally one of one hundred and fifty pounds is taken.*

They are kept temporarily in small ponds built of loose masonry, on the shore, at localities where there is a flow of sea-water through the beach, during ebb-tide, from the outlets of caverns. These are very favorable places for obtaining a constant renewal of the enclosed waters by natural means. The turtles are fed weekly until marketed, on the marine "turtle-grass," (*Zostera*) and sometimes on the weed "pusley" or purslane from the land.†

A large amount of excellent arrowroot was formerly grown on this island, but it is less extensively cultivated at present. The lighthouse, situated on a hill 188 feet high, affords a wide view of the eastern islands. Near the lighthouse there is a cavern, opening on the shore cliff.

A line of several smaller islands forms the southern and southeastern boundaries of Castle Harbor. Of these, Cooper's Island is

* Sea turtles of large size originally laid their eggs in the Bermuda beaches, but ceased to do so very soon after the settlement. (See Part III, ch. 31.)

† For these notes on the present turtle fishery I am indebted to Miss Victoria Hayward.

the largest. It is one of the islands on which the "Cahow," a remarkable extinct bird, peculiar to the Bermudas, bred in vast numbers when the islands were first settled. It burrowed in the earth, like the petrels, but its flesh and eggs, unlike those of petrels, were prized as food, and the species was exterminated in a few years. In Governor Butler's "Historye" he states that it was nearly exterminated in 1615, when there was a great scarcity of other food. (See Part III, chap. 29.) This island was also notable, in the early history of the islands, as one of the places where a Yellow-wood tree was found, bearing a cross and a brass memorial tablet, and hence it was supposed to have buried treasures upon it. (See Part III, ch. 26, *c*, under Deforesting.)

Cooper's Island is now largely cultivated. It is one of the few places where the great Land-crab (*Cardisoma Guanhumi*) can still be found, burrowing its large, deep holes in the sandy soil. A much smaller kind (*Gecarcinus lateralis*), with similar habits, is also found in abundance, as well as on most of the other islands where there is loose sandy soil. (See ch 32.)

The next island of any importance is Nonesuch, which is smaller than Cooper's. It contains about seven acres. The quarantine station is situated on this island.

The Ruins of the Old Forts.

Farther to the westward are several small, barren, uninhabited islands that are chiefly interesting because of the old ruined forts upon them. Some of these were built by the earliest settlers, between 1612 and 1621, with great labor and pains, to protect the entrances to Castle Harbor. The settlers lived for many years in constant dread of an invasion by the Spanish fleets, or privateers, and considered these forts of paramount importance. This fear, on the part of Governor Moore, was natural and justifiable, because of the instructions of the Company, from the beginning.

The colony had only been located a few months when in December, 1612, the Company sent out a special ship to warn the governor to prepare "with all expedition," to defend the islands against the Spanish, "whom they understood ere long would visit them." Later they blamed the governor for spending so much labor on the forts.

The earliest platforms, forts, and redoubts were built of cedar timber, but some of the platforms built by Governor Butler, 1619–22, were of stone. And perhaps some of those built in 1626 and 1627 were also of stone.

Most of the ancient forts now distinguishable were built of the limestone found close by, which was often of poor quality for buildings. All are now in ruins, for they were mostly abandoned before 1680, and several have never been occupied since 1630, though later ones have been built on the same sites to take their places, in several instances.

Castle Island is the most interesting of these islands to the visitor, for it is the one that was first fortified (1612), and its picturesque ruins are much more extensive than those of the adjacent islands. This is a rather high, small island, of a little more than three acres, and with only one small cove where boats can land, situated on the south side. The northern side and the ends consist of perpendicular or overhanging cliffs of considerable height.

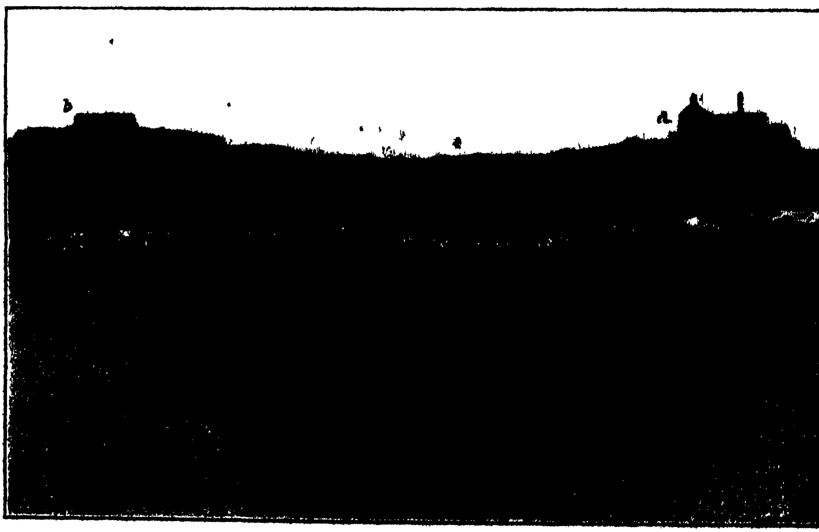

Figure 18.—Castle Island from Charles Island; *a*. Ruins of King's Castle; *b*. The Citadel or Devonshire Redoubt; *c*. Stone Sea-wall or Palisade; *e*. Barracks

The south side has a lower cliff or bluff. Along the crest of this was built a wall of masonry, with a gate at the landing. This wall is still standing and in fair condition, except at one point, where a small section was thrown down by the high seas and violent winds of the September 12, 1899, hurricane. This wall, in its present form, like some of the other old works, probably dates only to the period of the war of 1812. But in 1626 a large number of men were employed here in enlarging the fort and building "palisados," which

may have been the original wall, on the same site. (Plates lxxix and lxxx.)

The island itself is a barren-looking place, with thin dry soil between the rough limestone ledges, supporting a scanty crop of wiry grasses, weeds, and seaside shrubs, with an abundance of large prickly pears (*Opuntia*), but with no trees, except a very few small stunted cedars. According to the early writers, it was originally well wooded with cedar, like most of the other islands. The smaller land crabs burrow there, wherever there is sandy soil.

The native lizard is abundant among the ruins and in the crevices of the ledges, and can often be seen basking in the warm sunshine, but it is a very watchful and agile creature, and can seldom be taken alive. It has the habit, common to many lizards, of quickly dropping off its tail when in danger. (See Part III, ch. 31.)

The tropic birds are generally to be seen, in their season, flying overhead and screaming threateningly at the intruder into these their solitudes. They breed in the holes of the cliffs, and sometimes in the drains of the old forts and barracks. (See plate lxxii.)

The total effect of the place, to an imaginative person, is weird and desolate, like the ancient ruins of the old world. Governor Moore, in 1612, very soon after his arrival with the first settlers, mounted a gun or two on this island In 1613 he built a cedar platform on the "Gurnett Head," and mounted four guns upon it, and he probably also had built or commenced a cedar redoubt or magazine, as usual at that time. In 1613 (about September) two strange vessels, supposed to be Spanish, attempted to enter the harbor, but were driven away by the governor in the fort. The governor himself, who, according to Governor Butler, "was a very good gunner," twice discharged a "great gun" at one of the vessels, hitting it at the second shot. In this connection it is recorded by Governor Butler (1619) that it was lucky that the vessels did not attack the fort, for there were only four guns mounted and they had at the fort only about twenty men, "many of thoes very weake and feeble with want of foode," and they had but little gunpowder and only one spare shot. His account is as follows:

"Wherein certainely th'er was evidently a great deale of devine providence for the good of the poore plantation; for ther wer not at that time above twenty persons at the Gurnetts head, and many of thoes very weake and feeble with want of foode; ther wer then only foure peeces mounted, the which though they wer all of them laden, yet was ther not above three quarters of a barrell of powder besides, and one only shott."

Governor Butler also relates a quaint anecdote in regard to this affair, as follows :—

"Upon the very expectance of the entrance of these shyps, and in the hurrey of the preparation for a defence, the only barrell of powder that they had was improvidently tumbled vnder the mussell of one of the ordinance, the which being one of thoes two that wer discharged, the powder notwithstandinge, which lay thus under her, fired not certaine cartredges slightly made of paper and filled with powder, being brought up to be used upon occasion, a negligent fellowe left his lighted match upon one of them, all the whilst they wer at prayer, the cole whereof, though it continually touched the paper, yet kindled noethinge. Thes direct demonstrations of heavenly assistance exceedinge wrought upon most of them, and especially it moved the governour, who (as I find him generally) was noe lesse pious than painefull ; so that callinge his men together like a good christian and a soldier he publickly gave thanks to God for this his so protecting a preservation."

The first temporary cedar fortification, which was described as having four guns, was replaced by a larger one, built by Governor Moore, who was mentioned as assiduously engaged in this work in June, 1613, and March, 1614.

Governor Butler (1619) thus referred to the work as still going on at the arrival of the "Blessing" and "Starre" [about March, 1614,] with 280 new settlers:* "for some of them he sent to the Gurnetts head, to make that plattforme and rayse thoes battlements, that to this daye lie out upon the mouth of the harbor ; the which, haveing finished in some reasonable manner, was called the Kings-Castle."

Governor Moore built on Castle Island two cedar platforms and three redoubts : two of the latter on the top of Gurnet Head, which came to be called, more specially, King's Castle ; the other on the highest point of the island, to which Governor Butler, when he rebuilt it in 1620, gave the name of "Devonshyres Redoubt." But

* Within the first three years, up to the autumn of 1615, 660 settlers are recorded as having arrived, a large part of them ignorant and depraved, many having been taken from the slums and prisons of London and almost useless as pioneer colonists in a remote place like the Bermudas. It was fortunate, perhaps, that many of the laziest and most worthless died in the famines of 1614 and 1615. The first 60 seem to have been better men, though there were also some good men in the later arrivals. Governor Moore's task to take care of such a crowd of helpless men and women, without any adequate supply of provisions, must have been a terrible ordeal. (See Part III, ch. 28.)

the name "King's Castle" continued to be used as the collective name for all the fortifications on the island for at least seventy years later. It was also generally used as the name of the island itself by all the early writers.

The cedar fort or platform and redoubt, on the summit of the island (fig. 18, *b*), was burned in 1619, just at the time of the arrival of Governor Butler, but he very soon rebuilt it on a larger scale, cutting the platform, as he stated, out of the "maine rock." He also stated that when he left the islands, in 1622, there were efficiently mounted here seven guns, most of which they called sakers and "murtherers."

At that time the ordinary form of fortification here was merely a flat platform, either of rock or cedar timber, on which were placed the guns, mounted on cedar carriages, like those of a field piece. Nearby was built a musket-proof magazine, like a log-house, of cedar logs, in the form of a redoubt with a flat, or nearly flat roof, on which one or two guns were usually placed.

Governor Butler's letter to the Company [1620] contains the following statement as to this fort :—

"I began the recovery of the burnt redoubt in the Kings Castle, which is restored, and under it I have cutt (out of the maine rock) a convenient plattforme, whereon, upon newe carriages, I have mounted seven peeces of great ordinance, which are of great use for the foundering of any shyp that shall attempt a passage by force, as being lodged to shoote into her hould ; and besides they command into every nooke of the harbour, and I have bin bold to call it Devonshyres Redoubt (fig. 18, *b*, and fig. 19). From hence I went to the other plattforme,* that shootes selfe more out to seaward, wher, findinge scarce two peeces serviceable, I have newed and renewed all of them with substantiall carriages, and remounted the peeces. So that you have at this present three and twentye peeces of ordinance in gard of the harbours mouthe, wher you had not five any way serviceable at mine arrivall."

In another place Governor Butler stated that the rebuilding of the Devonshire Redoubt and the platform under it required the hard labor of thirty men for eight weeks.

In the illustrations published by Capt. John Smith (1624) the "Devonshire Redoubt" and "King's Castle" are represented just as described by Governor Butler, but there is another building, prob-

* This was the platform on the brow of the cliff at Gurnet's Head (fig. 18, *a*, and fig. 20, *m*).

ably the house of the captain, in the background of the latter.* (See fig. 20.)

A gun-platform cut out of the solid rock still exists on the extreme end of "Gurnett Head," and just under the walls of the old stone fort, or King's Castle, now in ruins. This probably is the successor of Governor Moore's platform, enlarged and improved, and furnished with embrasures. A sentinel box has also been cut out of the "main rock," and also oven-like niches for the cannon balls. An old iron cannon, dismounted and thrown over the sea-wall, may still be seen there.

Governor Butler, in his "Historye," writing of this fort, repeatedly speaks of it as built on "Gurnett Head," and often calls it the "Kings Castle on Gurnett Head." This name of the headland on Castle Island occurs at least seven times in his Historye. But on modern maps the name "Gurnet Head" is given to a headland on Cooper's Island, where Pembroke Fort was built by Governor Moore,—a "fashionable redoubt," as Butler called it.

In the "Orders and Constitutions of the Bermuda Company," 1621–2, the following reference to this headland occurs in the enumeration of public lands to be allotted:—

"To the Captaine of the Fort on [Cooper's] Island, with a Platforme over against the Forts at the Gurnards Head, two shares, and to the Captaine of the Forts on Gurnards Head, two shares."

The editor (Governor Lefroy) supplied the word Cooper's, which was missing in the above, but it is far more probable that *Southampton* was the island intended, for the fort there had a captain and was garrisoned at that time, while Pembroke Fort on Cooper's Island was not, but was cared for by one Carter,† the owner or tenant of the adjacent land. Moreover, there was no "platforme" there, but only a small cedar redoubt with two guns on its top.

The Rev. Mr. Hughes, who went out to Bermuda in Moore's time, also mentioned it in his "Letter sent into England from the Summer Islands," Dec., 1614, published in London, 1615, and this is the first place where the name was published. He says of Governor Moore: —"At the Gurnets Head he hath built three forts,‡ and planted them

* Gov. Butler stated that he built here a house of hewn stone for the captain of the Castle, taking his former mean frame house for a "corps du garde."

† This was the same Christopher Carter who remained on the islands two years, with only two companions, after Somer's death, in 1609.

‡ In the old illustrations published by Capt. Smith, in 1624 (see fig. 20) there are two redoubts and a platform shown on Gurnet Head, doubtless built by Governor Moore; and the new Devonshire Redoubt, built by Butler (1620) to

with great peeces, and men to defend them." It is also spoken of by Capt. John Smith (History of Virginia, etc., 1624) as "Gurnets Head." He says of Governor Tucker, 1616, that he "appointed Master Stokes, Lieutenant of the Kings Castle at the Gurnets Head."

By some unexplained error, or confusion of terms, the name came to be applied later to the headland at the southern extremity of Cooper's Island, where Governor Moore built in 1614 a fortification called Pembroke Fort, doubtless of heavy cedar timber. On most modern maps the latter is still erroneously called Gurnets Head.*

The "Gurnard Head," as used by the Company, is only the more modern form of the same word. In the narratives of various voyages of about that period, certain headlands are said to be shaped "like the head of a gurnet," or "gurnard." It was a common comparison at that time. Doubtless one or the other (or both) of these Bermuda headlands, as seen by approaching sailors, had a fancied resemblance to a gurnards head, but the resemblance may have now disappeared by erosion.†

Hughes' "Letter from the Summer Islands," 1615, and Capt. John Smith's History, ed. I, 1624, are the earliest books in which I have found the name. Governor Butler's Historye, which contains numerous references to the place, antedates the latter, but though written in 1619–26, it has only recently been published (1882), except those parts of it borrowed and printed by Capt. John Smith in 1624.

The name does not occur on Norwood's map of 1663 (at least not on the editions that I have seen), though it does occur on his map of 1622.‡ But the name is placed on the latter so far away from land

replace the one built by Moore on the same site, and burned in 1619. These were the "three forts" mentioned.

* The old writers do not give any clue as to the reason for the application of the name, but the same name has been given to high headlands in other countries, as for example, "Gurnet Head" on the north shore of Massachusetts Bay. "Gurnet" is simply an old form for gurnard—the name of several species of English market fishes having large, rough, angular heads.

† Viewed from the shore ledges on the south side, there is a very striking human profile to be seen near the base of the cliffs under the old "Kings Castle." (See fig. 21.)

‡ On this map both Latin and English names are given to many places The Latin name of Gurnets Head is given as "Hyrcae promont." Precisely what this means is uncertain. It may be bad Latin for "Hirci Prom." The name on the map is even outside of "Gurnet Head Rock," for which he may have intended it. But the fault may have been due to the Dutch engraver. In his map of 1663, the rock is correctly named. The use of the name "Gurnett Head" was well established before Norwood's first map was made.

and covers so much space, that we cannot be sure as to which headland he intended to designate by this name, but there is not the slightest doubt but that the headland of Castle Island was the true Gurnet Head. The names of "Tuckers Island" and "Brothers Islands" have also been transferred and interchanged subsequently to Norwood's maps and descriptions, 1663.

Situated outside of all the other islands, off the entrance to Castle Harbor under Gurnet Head, lies "Gurnet Head Rock." This is a high, very steep, rough, and rugged rock, rising sheer out of the water, with no beach, and very inaccessible except in smooth weather The sides are in most places nearly perpendicular and rise to sharp, ragged summits, with little or no soil, as I ascertained by personal examination, in 1901. This evidently took its name because it was off the Gurnet Head of Castle Island, and was most assuredly used for the bearings in entering the ship-channel under Gurnet Head, by the earliest navigators, before there were charts.

It is of scientific interest chiefly because it is still a possible breeding place for the "Pimlico" or Audubon's Shearwater, which has been mistaken by many writers for the extinct "Cahow." The latter could not have bred on this island, for there is no soil in which it could have burrowed to make its nests. (See plate lxxix, fig. 1, and history of the Cahow in Part III, ch. 29.)

The ancient wooden forts and redoubts undoubtedly were demolished, if not already decayed, to make room at a later period for the more modern stone structures, some of which were probably built at about the time of the war of 1812, when this island was again garrisoned. The islands were so much impoverished in the time of the Revolutionary war and the people were so much in sympathy with the American colonies,* that it is not probable that any new fortifications were built at that time, even if the old ones were repaired, which is doubtful.

On the highest point of the island, toward the western end, there is now a high stone redoubt, with embrasures for several guns. The

* It is a matter of history that the powder magazine at St. George's was robbed of all its powder, early in the war, and that the powder was sent to General Washington, at his request, and contributed largely to the success of the colonists. As if to emphasize their ill will and contempt of Governer Bruere, the stolen powder was carried through his grounds. In return, Congress allowed provisions to be shipped to the islands, where food was then scarce.

An autograph letter written by General Washington to the inhabitants of the Island of Bermuda, Sept. 6, 1775, in regard to the seizure of this powder, is still preserved. (The Writings of George Washington, by J. Sparks, iii, p. 77.)

steps, probably of wood, that led to its top are gone. It is surrounded by a stone fort of considerable size, and both are in fair preservation. This stone redoubt and the battery under it were evidently built on the site of Butler's ancient Devonshire Redoubt and platform, of 1620.

Near the western end there is another fort or battery, and the barracks, with the walls standing, but the slabs of stone have been stolen from the roofs and carried away by the natives of other islands, and all the timbers have disappeared, probably in the same way, but there are some iron pillars still standing here, so that these

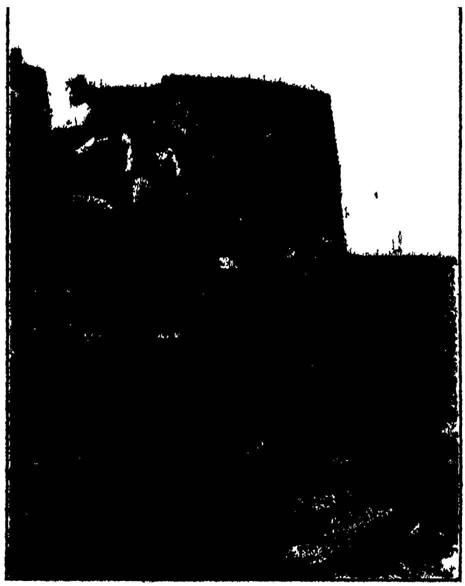

Figure 19.—Castle Island, the ancient Citadel or Devonshire Redoubt
Phot 1901

ruins look rather modern as compared with some others. Two of the old brick ovens remain, but small stalactites have formed in the interior. The vandalism of the natives from the other islands has probably caused much more destruction here than the elements.

Could we have been sure of the exact period when any of these works were built in their present form, they would have afforded us excellent geological data by which to estimate the rate of atmospheric erosion and decay of the ordinary limestone rock, of which they were built. The actual amount is quite variable in different places, but nowhere so great as we should naturally have expected in works

of this character, and in so exposed a situation, during so many years. But the absence of frost is a great factor in the durability of such rocks. Probably the official records would show when these later structures were built, but we had not sufficient time to ascertain it

I was not able to ascertain positively that any of the works now standing on Castle Island were built in the early period, before 1625, for though in the same places, the older works must have been totally demolished and new ones of larger size built later.

In the History of Virginia, etc., by Capt John Smith (1624), he reproduced a rough map of Bermuda, with the location of all the forts indicated, and with marginal illustrations of the forts and public buildings, including the Devonshire Redoubt and platform, with its seven guns, the King's Castle, and the Southampton Fort opposite. These curious illustrations were undoubtedly made by

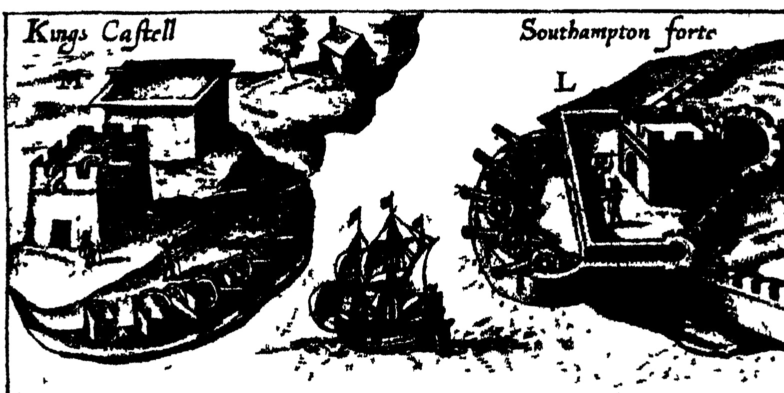

Figure 20 —Ancient illustrations (made by Norwood in 1622) of King's Castle (M) and Southampton Fort (L), first published in 1624. Reduced by photography.

Richard Norwood and furnished to Smith,* either by Mr Norwood or by Governor Butler. Mr. Norwood had just before that time completed an official survey and map of the islands, with its divisions into shares, for the Bermuda Company. He was a very able engineer and surveyor, long resident on the islands, and must have been very familiar with every part of them. So his illustrations, though rude and all out of proportion as to the land and water, are probably correct enough to give a good idea of the works, as they

* Capt. Smith credits his illustrations to Norwood.

stood at that time. Moreover his figures agree well with the contemporary descriptions by Governor Butler, as to the number of guns in each fort and other particulars. Butler himself alludes to such figures, probably the very ones published by Smith.

Governor Lefroy, in his edition of Butler's "Historye," has reprinted this illustration. Norwood's original maps of that period are remarkably accurate.

I have here reproduced some of the illustrations of the old forts, taken from Capt. John Smith's History. In the view of King's Castle a vessel is represented as passing through the narrow channel, under Gurnet Head, and Southampton Fort is shown on the other side, as described by Governor Butler, who built it. But no attempt has been made by the artist to show the actual form or height of either island, or the width of the channel, as compared with the size of the ship and forts, for the channel here is perhaps a quarter of a mile wide. It is, in fact, in these respects intended to be a mere diagram, but it was probably also intended to give a fair idea of the form and character of the forts or platforms themselves, and of the redoubts or magazines, and more especially the number of mounted guns.

Governor Butler states that Southampton Fort was the only one properly planned and laid out for defence, and the illustration certainly shows a style of construction very different from any other, and more like the larger forts of the Old World (fig. 20). Its ruins can now be seen, having nearly the form here represented. It is enumerated as among the forts in use in 1677, in the statement made by the Company, and it was still garrisoned in 1693. I have found no mention of its having been repaired or rebuilt in later times. Governor Lefroy (about 1876) speaks of it as showing its original form, and in fair preservation, at that time. Scientifically it is, therefore, of much more interest than the works on Castle Island.

The northern side of Castle Island was so high that boats could not land there except at the foot of stairs cut out of the solid rocks. These must have been used when the seas were beating on the south side. There was also a well and windlass for hoisting freight from boats on that side, where the cliff overhangs. Two large brick water-cisterns, with their stone catchment platforms, on the slopes of the hills, are still in pretty good condition, and are full of good water, but they are probably not very ancient. (See plate lxxix, fig. 1, *b*, *c*.)

Early in 1620, Governor Butler built the opposite fort on Southampton Island, and mounted there five guns, most of which he raised from wrecks. His description of it is as follows :—

"The Governour is noe sooner returned out of the maine to St Georges, butt he setts twenty men of his owne people on worcke at Southampton Forte, the which after six weekes of hard labour is absolutely perfected, and the whole worck shutt in, and ordinance secured, by three smale bullwarcks, two curtaines, and two ravelins: the which not only (being thus putt together) maketh a very fayre shewe out to sea, but is, with all (the naturall site of rock exceedinglie well concuringe) very strong and defensible ; being (to saye the truth) the only true peece of fortification in the whole Ilands."

Figure 21.—Castle Island ; Gurnet Head in profile, with ruins of King's Castle on the top ; Profile, (*a*) at base of cliff ; (*b*) Ruins of Southampton Fort. 1901.

He also built there a cedar redoubt for a magazine. The main ship-channel lies between this fort and the "King's Castle." Three of the guns for this fort he raised from the wreck of the Warwick, "with infinite toyle and much danger." If we consider the small size of the guns of that period and their short range, whether on land or ships, these works seem to have been very well planned, but their strength was never actually tested by hostile ves-

sels, though somewhat suspicious vessels were sometimes scared away, just as well as by many modern forts of greater size. (Fig. 21, and plate lxxix, fig. 2.)

Additions and repairs were made to King's Castle at various times, and it seems to have been garrisoned almost continuously for over seventy years, though the regular garrison usually consisted of only 12 men.

In consequence of the war with Spain, the Company in a letter of March, 1626, ordered Governor Woodhouse to see that the forts, especially King's Castle, were kept in order and well guarded.

As a result of this, extensive repairs were made and new works were built at the King's Castle from May to November, 1626. A levy of men from all the tribes was made, each man to give two days labor or furnish a substitute, the men to work in gangs of 15 each.

Items charged for the special or skilled labor indicate that considerable changes were made. There is a charge of 120 pounds of tobacco for 1,000 feet of cedar planks for the platform, etc.; 400 pounds for the foundations; 394 pounds for mounting the ordinance and for the "palisado;" 425 pounds for iron work of the gun carriages, etc. Altogether, 3,025 pounds of tobacco were demanded for this work.

There is no special description of the work done, or needed to be done, nor any statement of the number of guns mounted. It seems strange that so many repairs were needed within four years from the time that Governor Butler had left the works in good order and the 16 guns mounted on new cedar carriages. There is no mention of new guns. A little later there were charges of dishonesty and fraud preferred against Capt. Stokes, who was then in command of the fort, and Capt. Felgate, who superintended the work, and they were both discharged from the service, in disgrace, showing that the public interests were sometimes poorly looked after there,—much as in modern times, and other countries, on a larger scale.

In November, 1626, a new fort was ordered to be erected on Peniston's Island (now Paget Island), about where Fort Cunningham now stands.

For this work every owner or "halver renter of land," and every servant receiving wages, was required to give 10 days of labor or its equivalent in substitutes. Wages were reckoned at 2½ lbs. of tobacco per day, without board, or 2 lbs. "and his victuals." The men were to work in gangs of 40 at a time, in rotation. At that time the land had to be cleared. There is record of a special charge of 120 pounds of tobacco for felling the trees on the site.

But I have found no description of the nature or amount of work actually completed there.

Among the old records are numerous entries of amounts paid to the garrison and for supplies of various kinds, up to 1690 or later. Southampton Fort was also in use as late as 1693.* The usual amount of pay was 170 pounds of tobacco annually, for each man of the garrison; for in those times tobacco was the regular currency of the islands, not only for the payment of wages and salaries, even of the governor, but also in ordinary trade and barter. In 1622 tobacco was valued there at 2 shillings 6 pence per pound, but the people claimed that this was too little. In 1629 there is a record of amounts in tobacco paid for cedar lumber, nails, rosin, tar, etc., for a new water cistern and platform at the King's Castle, as well as for the labor of building it.

Repairs were recorded as made at King's Castle and Southampton Fort in 1660, and a new cedar platform was made at King's Castle.

It was used as a prison in 1649, and it is recorded that it was made the place from which the pilots should go out to ships in 1656.

In June, 1672, much alarm was felt on account of news of the war between England and Holland. Consequently the forts were repaired, guns were remounted, and a new fort was ordered to be built, at an unfortified place, but the locality is not recorded. Perhaps this was the very old stone redoubt at the entrance of Hungry Bay, now in ruins, but with part of the side walls standing. All the guns were ordered tested with double charges in 1674.

The King's Castle was again repaired and the guns were put in order by Governor Coney, in 1684.

As the extinct "cahow" was still abundant on the adjacent islands when the earliest fortifications were built on Castle Island, and as it must, undoubtedly, have furnished part of the rations of the workmen and garrison up to 1616, it was thought possible that by a careful search in the adjacent soil, or in the kitchen-refuse of those ancient works, if any could be found, some of the bones of the cahow might be discovered. Probably most of their rubbish was thrown over the high cliff, directly into the sea.

A considerable mass of debris, mixed with "kitchen middens," was, however, overhauled close to the old fort on Gurnet Head, but no cahow bones were found, though there were bones of common birds, fishes, and domestic animals in good preservation, showing that the calcareous soil is suitable for the preservation of the bones.

* One of the depositions made in 1693, in regard to buried treasures, was by Capt. Braugman, commander of Southampton Fort (See ch. 26, c.)

We also found gunflints and flint cores from which they had been made, silver and brass military buttons, broken clay pipes, etc. All these, however, probably belonged to the period of the war of 1812. Charles Island, or "Goat Island," a little farther south, is rather smaller and still more barren, as it is covered in some places with drifting sand. It also has the ruins of a small fort on its highest point. This stone redoubt was built by Governor Moore about 1614, and mounted only two guns. (Fig. 22.)

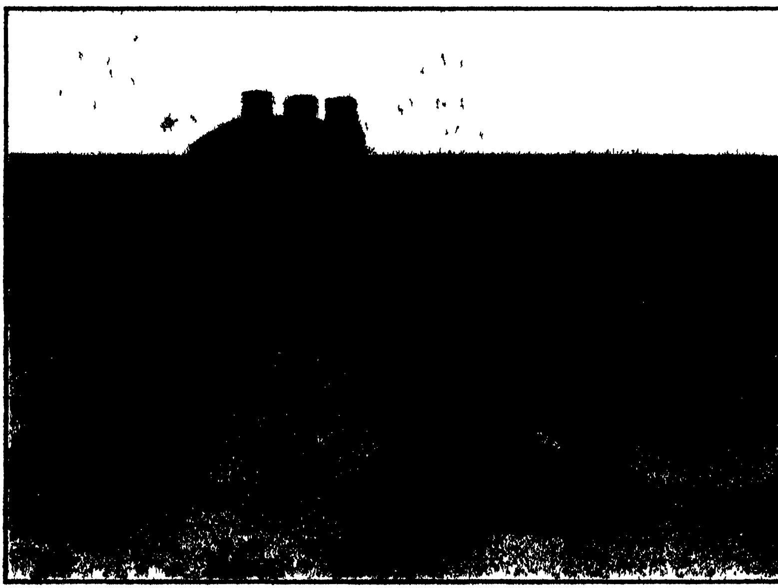

Figure 22.—Charles Island and Ruins of Charles Fort, built about 1614.

Norwood, the engineer, stated in 1663 that this fort was even then "fallen into decay." In digging into a bed of loose sand, undermined by the sea, on the north side of this island, we found an abundance of large fossil snail shells, of a species not now living on these smaller islands, and nearby, two skeletons of soldiers, associated with military brass buttons, made in Dublin, and stamped with three mounted cannon, in a row, indicating an artilleryman.

The most interesting finds on Castle Island were the broken pearly shells of the West Indian Whelk (*Livona pica*), which had, apparently, been used as food. This mollusk, which is eaten in the West Indies and called the "whelk," has been so long extinct in the Bermudas that nothing is now known of its former presence in the living state. Its large, thick, mottled, and partly pearly shell is

common as a fossil in the æolian limestone all over the islands, even on the highest hills, and is often seen loose, where the soft rock has decayed. More often it may be seen carried about on the backs of the large land hermit-crabs, whose ancestors, many thousands of years ago, carried these same shells inland from the shores to the ancient sand hills. (See chapter on Geology and figure.) But this occurrence of the broken shells in the kitchen refuse, would indicate that this West Indian "Whelk" was living in these waters in 1812. (See Part III, ch. 32, and ch. 46, Geology.)

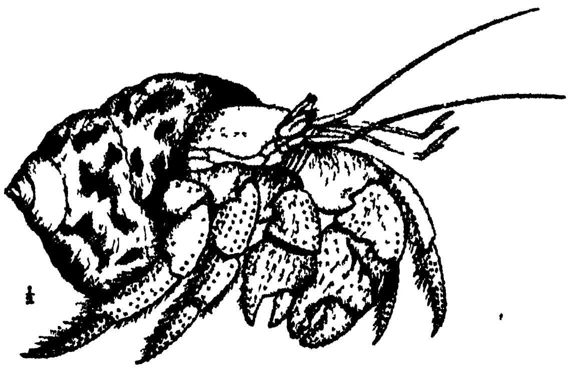

Figure 22*a*.—The Land Hermit-crab (*Cenobita diogenes*) carrying fossil marine shell (*Livona*) on its back.

Part II.—Physiography, including Meteorology, etc.

1.—*Geographical Position.*

The dry land of the Bermudas is mostly included between N. Lat. 32° 15′ and 32° 23′ and W. Long. 64° 39′ and 64° 53′. But the reef areas extend between 32° 12′ and 32° 30′, N. Lat.; and between 64° 34′ and 65° 02′ W. Long.

These islands are remarkable for their isolation from any other lands, and the depth of the ocean around them.

I am indebted to Professor S. L Penfield for the following measurements of distances on the maps made according to his new method of stereographic projection. They are believed to be much more accurate than those hitherto given :

Bermuda to	New York,	675	nautical	miles.
"	Cape Hatteras,	575	"	"
"	Martha's Vineyard,	615	"	"
"	Cape Cod,	620	"	"
"	Cape Sable, N. S.,	675	"	"
"	Great Abaco Is., Bahamas,	715	"	"
"	Porto Rico,	830	"	"

2.—*Forms and Extent of the Islands and Reefs.*

The existing islands of Bermuda must be regarded as the remnants of the higher parts of a submerged and very much eroded, older limestone island, of much larger size, which has been well called the "Greater Bermuda." It might, perhaps, be as well called the Pliocene Bermuda, from a geological point of view.

The outline of the Greater Bermuda is preserved by the outlying limestone reefs that surround the present islands on all sides. These reefs have an elliptical outline, about 22½ miles long and 11 wide, in the widest parts, and cover about 250 square miles.

They consist of æolian or sand-dune limestone, like that of the dry land itself. They are, in most parts, covered with coatings of living corals, corallines, and algæ, that retard the erosion by the sea. In most places they rise nearly to the surface of the sea, and at extreme low tides large, flat areas of reefs rocks, called "flats," are laid bare.

Therefore they are extremely dangerous to navigators, even now, though the two excellent lighthouses and the excellent modern charts have greatly reduced the danger.

The outer reefs, on the north side, enclose large areas of irregular scattered reefs of the same kind, and also several large sunken lagoons and anchorages of deeper open waters, with bottoms covered with tenacious, white, calcareous mud and shell-sand, thus affording good anchorages, large enough to accommodate the largest fleets of vessels. These are often 50 to 70 feet deep, and sometimes deeper than that in places. The entrances are narrow and few. Murray Anchorage and Great Sound are good examples of these. (See map.)

The dry land of the islands consists of over 150 islands and islets, many of them very small; together they form a narrow, hook-shaped group, about 14 miles long, in a straight line, and mostly from one-half to two miles wide. The total area is about 12,400 acres, or 19⅜ square miles, of which about 3,000 acres is said to be arable.*

* Some of the other islands, of less importance, with their approximate areas, according to Norwood's 1663 survey (fractions usually omitted), are as follows:

Cooper's Island, 77 acres.	Boas Island, 4 acres.
Paget or Peniston I., 31 acres.	Yates Island, 31 "
Long Bird Island, 46 acres.	Elizabeth " 21 "
Smith's Island, 61 acres.	Tucker's " 21 and 7 acres. (Now Daniel Island and Benets Island.)
Nonesuch " 15 "	Brother's Islands, 20 and 17 acres. (Now Tucker's Island and Morgan Island.)
Coney " 14 " 8 roods.	Trunk Island, 8 acres.
Castle " 8 " 2 roods.	
Southampton Island, 1 acre 2 roods.	
Charles Island, 8 acres 8 roods.	

Norwood stated that most of these sizes are only estimates. But they agree closely with the official estimate made in 1875.

The bulk of the land is contained in the Main Island, which is about 11 miles long, and contains about 9,725 acres. Four other islands are of considerable size. Two are at the western end: Somerset Island, with 702 acres; and Ireland Island, with 133 acres. At the eastern end are St. George's Island, with 706 acres; and St. David's Island, with 527 acres.

The Main Island is connected by bridges with St. George's Island and Long Bird Island at the eastern end; and with Somerset Island, Boas Island, and Ireland Island, at the western end, so that one can drive by good roads from one end of the group to the other. But St. David's Island and many of the smaller islands can only be reached by boats.

3.—*Hills, Valleys, Sinks, Brackish Ponds, Swamps.*

The land of the larger islands is everywhere hilly. The hills are mostly gently rounded and are nothing but consolidated sand-dunes, consisting of shell-sand, blown from the beaches in ancient times, and hardened or cemented by the infiltration of rain-water temporarily holding some of the limestone in solution, as will be more fully described in the chapter on Geology.

This mode of origin, as sand drifts, accounts for their rounded forms and irregular arrangement. Several of the higher are over 200 feet high; the highest is 268 feet. This is an unusual height for sand-dunes, but is exceeded in the Bahamas and some other countries But before the great submergence of these islands these hills must have stood at least 100 feet higher than now. (See Geology.) The great violence of the storms that often visit these islands; the lightness of the materials; and the fact that the hills when once formed very soon harden at the surface, so that the subsequent storms cannot cut them down again, are sufficient reasons for their great elevation.

Between the hills are irregular valleys of various sizes. Many of these are surrounded by hills or higher land on all sides, so that they have no outlet. (See plate lxv, fig. 2.) They never contain water unless they are so low that they extend below the level of the sea; in such cases they contain salt or brackish ponds, fresher at the surface, of which there are several of considerable size, as well as many smaller ones.

A line of sinks, part of them containing brackish ponds, extends from Tucker's Town westward for several miles to Paget Parish, nearly parallel with the south shore of the Main Island, and not far

from it. Some of these are connected with the sea, like Tuckers Town Bay, Trott's Pond, and Peniston's Pond; others are separated from it by narrow and low divides or ridges. In severe storms the sea pours in large quantities over the low divide into Peniston's Pond, which is the largest of the ponds, so that ultimately, and at no distant time, it will doubtless form a breach and thus convert the pond into a bay or harbor, like Hungry Bay and many others.

Hungry Bay was evidently at one time a pond of the same kind, which has been breached by the sea. The tide now flows in and out, through a narrow channel, in a rapid current. This bay is shallow and the inner end terminates in a dense mangrove swamp of considerable extent. It is a favorable place for zoölogical collecting. When the interior valleys or sinks are not quite so low, but yet extend below the level of the sea, they usually form swamps, peat bogs, or marshes, with thick beds of peat or muck. Pembroke marsh and Devonshire swamp are large peat bogs of this description. Borings have shown that the peat in Pembroke marsh is about 40 feet deep, and its bottom extends many feet below the level of the sea, showing that the land has subsided considerably since the beginning of its formation, for peat does not form in the salt ponds or bogs. Peat bogs have also been dredged up during the harbor improvements, at considerable depths. (See Geology.)

The vegetation in some of the swamps is very dense and luxuriant. This is the case especially in Pembroke swamp. The Palmetto grows tall and slender in such places (fig. 32). Among other plants, the ferns are very conspicuous. Some of these grow to large size, especially the two species of *Osmunda*, which are also found in the northern United States; the common brake or bracken (*Pteris aquilina*); and the Marsh Fern (*Acrostichum aureum*), a large West Indian species. (See Part III, ch. 24, Botany.)

Absence of Streams and Springs.

Owing to the great porosity of all the limestone rocks, surface water does not collect sufficiently at any place to form streams, springs, nor ponds. Rain-water, collected in cisterns, is the universal water supply,* and owing to the abundant rains, it seldom fails, with ordinary care. The roofs of the houses are mostly covered with slabs of limestone, cemented, and arranged to catch all

* There are a few exceptions to this rule, for three or four recent wells, of moderate depth on high land, have proved successful.

the rain-water. But in many places on sloping hillsides, platforms are built of similar slabs of stone to conduct the rain-water into large cisterns at the base of the slope, as at Castle Island. (See plate lxxix, fig. 1.)

4.—*Fallen Caverns and Natural Fish Ponds.*

In many places small and deep valleys or abrupt depressions occur, which are called "sinks" or "plantation holes" Most of these, if not all, have been caused by the falling in of roofs of caverns, which are of frequent occurrence here. Vegetation is often luxuriant in such places, owing to the rich soil, increased moisture and heat, and the shelter from the high winds.

When these sinks are formed by the falling in of caverns that extend below sea-level, they result in the formation of excellent natural fish-ponds, for they have subterranean connections with the sea that serve to renew the water constantly and keep it pure.

Many of these exist. The one best known is the "Devils Hole," situated close to the west end of Harrington Sound. This is about 100 feet across, and the water is said to be about 40 feet deep. It is now enclosed and kept stocked with a large number of fishes, mostly Hamlet Groupers, for exhibition purposes. It is a place of much interest to visitors. (See p. 436.) Three ponds of the same kind are situated near the old Walsingham house, close to the shore of Castle Harbor. The largest of these contains several fine sea-turtles. The others contain many bright-colored fishes of various kinds. Another very interesting pool of this kind may be seen close by the road-side on Coney Island, just after crossing the causeway that leads to this island. It is on the right hand side of the road, and only separated from it by a rough board fence. It has perpendicular and overhanging rocky sides, but at the bottom there is a considerable depth of clean, transparent water. In a calm day large numbers of interesting fishes, some of them of large size, can be seen leisurely hunting for food among the masses of fallen rock at the bottom. But they suddenly disappear into the cavernous places at the least alarm. The principal fishes noticed here were the "Sea Lawyers" or Gray Snappers, which took the initiative in all the evolutions, and whose movements all the others followed in case of supposed danger.

There were also large blue Parrot-fishes, Pilot-fishes, and several other kinds. They are said to have entered this place through small

hidden crevices when young, but cannot now escape. It is certainly a very beautiful natural aquarium.

5.—*Harbors and Sounds.*

In many cases the gradual erosion of the sea-cliffs by the waves and the encroachments of the sea, have connected similar sinks and natural fish ponds with the outside waters by means of narrow or wide channels, thus forming partly enclosed harbors, lagoons, or bays, as they are variously called. Every stage in this process can be seen in progress. There is a little landlocked cave on Coney Island, with a shell-sand beach, but connected with the open water only by a narrow channel, between high limestone ledges, barely wide enough for a row-boat to pass through (figure 23). A similar miniature harbor may be seen near the roadside between Bailey Bay and Shelly Bay. It is said to have become connected with the sea in quite recent times. It is easy to see that this same process, when it opens up a larger valley or sink, will give rise to larger lagoons and

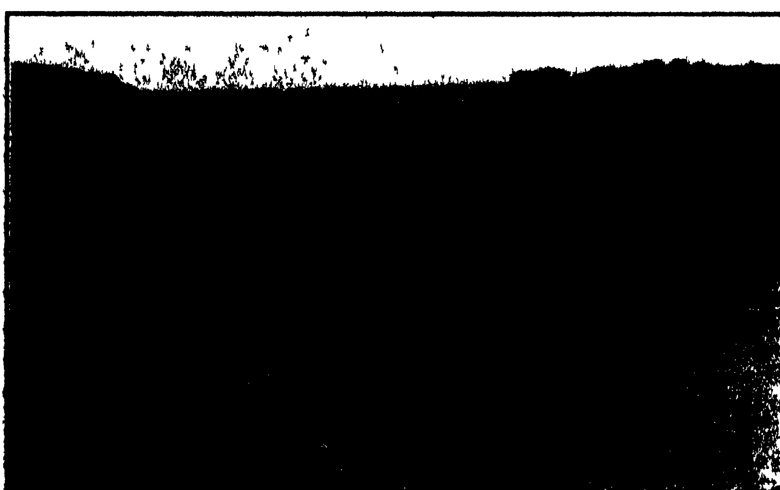

Figure 23.—Cove at Coney Island, with a narrow entrance

harbors. No doubt Hungry Bay, Harrington Sound, St. George's Harbor, and other harbors have been formed partly in this way, though doubtless in combination with the effects of the great subsidence of all the land that took place in a late geological period. (See Geology.)

6.—*Mangrove Swamps.*

When small bays or lagoons are thus formed by the invasion of the sea, if they should be sheltered from violent waves, mangroves and black-jack trees take root in the sea water itself, as well as along its borders. By means of the peculiar descending shoots or aërial roots of the former and the ascending shoots from the roots of the latter, a dense thicket or mangrove swamp is soon formed, admirably adapted to collecting and retaining dead leaves, mud, and sediment of all kinds, thus gradually increasing the area and fertility of the land. (See plates lxviii, fig. 2, and lxxiv, fig. 1, and Native Trees, Part III, ch. 26, *e.*)

Such mangrove swamps, usually of small extent, exist in many places, as at Coney Island, Walsingham, Spanish Point, Tucker's Town, etc. Larger and denser ones may be seen at Hungry Bay, Mangrove Bay, and several other places.

7.—*Caverns and Grottoes.*

Among the more interesting of the geological phenomena are the numerous caverns, usually hung with numerous huge stalactites, but sometimes with innumerable small and delicate ones; and in some places decorated with the most delicate fret-work, or with thin, translucent draperies, of snow-white stalactitic material.

Some of these caverns are of considerable extent, but the larger ones are generally partly submerged below the level of the sea, so that the floor may be covered with clear sea-water, 10 to 20 feet deep. Sometimes stalagmites can be seen rising up from the bottom, beneath the sea water. A large cavern on Tucker's Island,* of this description, had been fitted with pipes for acetylene gas and the proprietor had a boat inside, with which he, like Charon, took his visitors across the dark and mysterious waters. In this cavern the stalactites are of colossal sizes, but they are dark and dull in color, as if finished ages ago, as indeed they doubtless were.

On the Walsingham place there are several well known caverns. We succeeded in obtaining photographs of two of these. (See plates xc–xcii.) One of them has two entrances and does not contain water, though it is in a depression, not much above sea-level. It is near Thomas Moore's famous Calabash Tree. The stalactites are of large size, but badly smoked by the torches and bonfires of the innumer-

* Since my visit, this island has been converted into a prison-camp for the Boers, and is not at present accessible to the public.

able visitors, during nearly 300 years. Another, not far away, contains a deep pool of sea-water, but as there is no boat in it, the visitor can only view, from one side, the long sloping roof, hung with stalactites of various sizes. Many of these have been broken off by the vandals who have visited it, and all are badly smoked. But nevertheless, though its beauty has been so much marred, it is an interesting place to visit The most beautiful stalactitic formations that we saw were in the Peniston Cave, near the Harrington House, to the west of Walsingham. This cave can only be entered though a small and rather difficult passage, near the top of a rather high hill. It descends with a steep slope for about 80 feet. In the bottom there is a deep pool of clear sea-water. The sloping roof is hung with thousands of beautiful, slender, white stalactites, many of them very small, not much larger than a lead pencil, and still forming, for needle-like crystals of limestone can be seen forming in the drop of clear water that is suspended from the tips. This cave also contains elegant drapery-like deposits of white stalactite, in many varieties.* (See plate xciii and Geology.)

Many other caves, which are accessible to visitors, are known upon the islands. There is a cave on St. David's Island, near the lighthouse, but I did not visit it. Among the well known caves are Joyce's, Paynter's, Chalk, Church, Cooper's, Hall's, etc.

The cave on Somerset Island, known as Basset's, is of great extent, for it is said to have been explored for more than a mile, but it has only a few stalactites. See Geology for additional descriptions.

Along the high shore cliffs there are many grottoes and caves that can only be entered from a boat, and sometimes only at low-tide.

Two large dome-like grottoes of this kind, accessible only by a boat at low water, are situated close together in the shore-cliff a short distance east of Bailey Bay. One of them is lighted from above by a small chimney-like opening in the roof. They have more or less of the shape of huge Indian lodges or wigwams inside, and might well have been called "wigwam grottoes," if they ever had a name, or needed one.

Smaller grottoes in the shore cliff exist at Clarence Cove, and in many other places, and many are entirely submerged, under the

* This cave has not yet been opened to the public, and the walking and climbing over the steep, wet slopes, covered with fallen rocks and slippery red clay, render it unsuitable for most visitors, especially ladies, until its exploration shall have been made easier by enlarging the entrance and making steps, where needed.

coral reefs, and are the abode of innumerable fishes, octopi, and various other marine creatures. (See plate lxxiii, and Part VI.)

The character and mode of formation of these caves and grottoes will be more fully discussed later, under Geology.

8.—*Shore Cliffs; Natural Arches; Pinnacles.*

Along nearly the whole length of the southern sides, and on parts of the northern shores of the islands, there are broken and very rough cliffs of limestone, often of considerable height, and not infrequently perpendicular or overhanging. The irregular stratification of the limestone, with layers of unequal hardness, and sloping in all directions, which is characteristic of all such æolian limestones, causes this rock to be admirably suited for the ocean waves to carve into curious and fantastic forms.

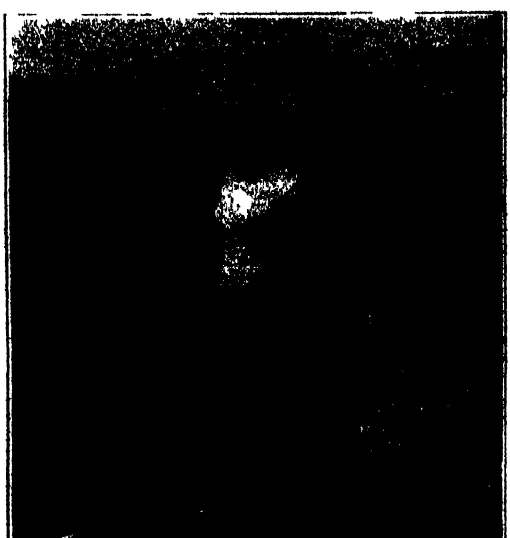

Figure 24.—Chasm and Natural Bridge on Cooper's Island.

In some places former headlands have become detached from the shore and worn by the waves into towers, pyramids, pinnacles and other curious forms, which are often very picturesque. The surface of the rock is deeply eroded and honeycombed by the spray, and covered with hard, projecting, sharp points, so that it looks very rough and weather-beaten, and it is certainly very rough to climb over. In most places, where long exposed, it has a dark color.

"Pulpit Rock," on Ireland Island, is a good example of a detached pinnacle rock. (See figure 25.) It also shows well the irregular stratification of the æolian limestone. Some of these pinnacles stand out some distance from the shore, on the flat reefs, showing where an islet, or the shore cliff once stood, long ago.

Figure 25.—Pulpit Rock, Ireland Island.

The famous North Rocks (figure 30) are pinnacles of this kind, standing on the outer reef, some eight miles from the north side of the islands. They stand on a broad platform of reef rock. They serve as monuments to mark the position of what was once a large and high island. (See Part III, ch. 28, and Geology.)

In other cases, owing to the unequal hardness of the rock, and to the frequent existence of masses of unconsolidated sand in the limestone, the waves have eaten away these softer parts very rapidly, leaving the harder parts standing.

This has sometimes resulted in the formation of natural arches or bridges, of which the double "natural arch" near Tucker's Town is a good example. (See plate lxxxvii.)

9.—*Cathedral Rocks.*

The Cathedral Rocks, or "Old Church Rocks" as they are often called, on the west side of Somerset Island, have been formed in a

similar way. (See p. 427 and plates lxxxviii, lxxxix.) The sea has here washed out vast quantities of soft rock or scarcely consolidated sand, such as occurs in many places along that coast, and has left the harder parts standing as large, roughly fretted and fluted columns, 12 to 15 feet high, which are partly roofed over by the upper and harder layers of limestone. (See under Geology.) These column-like rocks are very curious and picturesque, but are neither so tall nor so massive as they appear to be from the photographs.

Similar rocks, but not roofed over, exist at Tobacco Bay, a cove near Fort Catherine, on St. George's Island, and in other localities. (See plates lxxx, fig. 1, xc, fig. 1, and Part IV, ch. 40, Geology.)

10.—*Sand Dunes and Drifting Sands.*

As the entire mass of the land consists of hardened sand-dunes, we should naturally expect to see the process of forming them still actively going on. But at present this is not the case, except in one well marked district at Tucker's Town, near the southeastern end of the Main Island, and in a few other very local spots.

At the time that Matthew Jones wrote, 1872 to 1876, there were extensive moving sands on the south side of the Paget hills, near Elbow Bay. Even as late as the visit of the Challenger (1883) those sands were still moving, and both Moseley and Thomson gave very interesting accounts of them. At that time there was to be seen the chimney of a small stone house projecting above one of the sand-dunes, all of the rest of the house having been buried in the sand.* Partially buried trees were then visible, with their dead branches projecting out of the sand. But within a few years these drifting sands at Elbow Bay have become practically quiescent and fixed. Matthew Jones, in 1876, gave the following detailed account of these sand-dunes, which is of interest as showing the contrast with the present stationary condition.

"On arriving at the northeast corner of the sand-hills, the encroachment of the drifting sand will at once be perceived; as the mass, some ten feet in depth, is now gradually covering a small garden. According to the observations made by persons residing close to, this overwheming body has advanced over the cultivated land about eighty yards, during the last twenty-five years. At the northeast corner of the hills, will be seen among some oleander trees near the top, the chimney of a cottage which formerly stood there,

* Another house is said to have been buried at Tucker's Town, but the chimney is said to have been dug out, for the sake of the bricks and stone.

inhabited by a coloured family. It is now wholly buried in the drifting sand, save the chimney; which alone rises above the mass to show the position of the structure."

"With the exception of a few irregular patches here and there, and the long reach of white sand gradually encroaching on the cultivated ground at the northeast corner, the whole slope, which some twenty years ago was almost wholly clear drift sand, with a few patches of bent-grass in scattered spots upon it, is now clothed with wild plants and shrubs, as well as young cedars which will no doubt in a few years attain goodly dimensions, and with the aid of the universal underwood of sage bush put an end to the further encroachments of the sand drift. If people, however, are allowed to cut down cedars, and destroy the vegetation as they have formerly done, the same devastation will commence again, and repeat the calamity which has visited this neighborhood."

"On the western side of the sand hills, there is now a plateau of about half an acre, or perhaps more, of hardened drift sand, forming gradually into rock. On its face are cracks filling with drift sand; showing that the sun doubtless affects this hardened surface. Elevated stumps of a foot or so in height, rise amid this plateau; having each a hole or depression at the centre. These denote the sites in which cedar trees formerly grew. At the east end of the hills may be seen the gradual decay of cedar stumps, exhibiting more clearly the several stages of change; which are the more worthy of study in consequence of the light they throw upon the many curious chimney-pot looking structures* everywhere to be met with on the Bermuda shores."

In 1897, Stevenson observed that the sand had advanced but little in the previous 20 years, and that the chimney had been buried only 18 inches deeper than when figured by Thomson, over 20 years before.

The loose sand in this district has drifted to the height of at least 150 feet, in recent times, and to a third of a mile or more inland.

In 1901, the drifting of the sand had practically ceased and the sand hills were fast becoming covered with vegetation.

The fixing of the sand has been brought about mainly by the encroachment of sand-loving vines, shrubs, and grasses. Many of these are of foreign origin and have only been introduced in modern times, and in some cases not originally for this purpose, as

* These are the structures that have been considered casts of the trunks and bases of palmetto trees. (See Geology and plates lxxxiv–vi.)

in the case of *Lantana*, which was first planted as a fuel supply. Among the plants that have been efficient in stopping the sand are the sage-bushes (*Lantana*); the "black berry" (*Scævola lobelia*); the sea-side morning glory (*Ipomæa pes-capræ*); the bay lavender (*Tournefortia*), and other herbaceous plants; and also several grasses, of which *Cenchrus tribuloides* is probably the most important. In some places, a little away from the seashore, the *Lantanas* completely cover the sand-hills and are very effectual in stopping their drifting. In other sections, even close to the shore, the *Scævola* has thickly covered the newer sand-hills with its rootstalks and prostrate branches, and as its thick leaves, growing in tufts, seem to be almost unaffected by the salt spray, it is a very efficient binder of the sand. (Plate lxxvi.) This has now already abundantly invaded the sand-hills of Tucker's Town, close to the shore, and probably they may also become stationary, by its aid, in a few years, for other plants will soon come in to reinforce this pioneer. This result could easily be hastened by the intelligent planting of suitable plants in the loose sand.

On the south shore, at Tucker's Town,* both east and west of the "Natural Arches" for about a mile, there are extensive broad flatish beaches of white shell-sand. (See plates lxxv and lxxvi.) The strong southerly and southwesterly winds at times pick up the dry sand from the upper part of the beaches in large quantities and sweep it up the sides and over the tops of the adjacent hills to the height of 60 feet or more, very much as our winter winds will drift dry snow.

Fortunately these calcareous sands, if undisturbed for a time, have the property of becoming cemented together into a crust at the surface, in a short time, by the action of the rain-water, which, by virtue of the carbonic acid gas that it contains in solution, can dissolve the limestone particles. Then, by partially evaporating, it can deposit it again as a cement between the grains of sands, thus binding them together more and more firmly. Thus it is only necessary that the vegetation should be able to protect the sand from the action of the ordinary winds, for perhaps a few weeks at a time, when, by this cementing process, the surface may become able to resist the action of the stronger gales; still, even after a considerable

* Tucker's Town was so named because Governor Daniel Tucker laid out a town here in 1616, with regular streets and house lots in squares, and he also built some small frame houses of cedar. It is recorded that he also planted here sugar canes and hedges of figs and pomegranates, in 1616. The streets and buildings are indicated on Norwood's map of 1622.

crust has been formed, an unusually severe storm may cut into the weaker spots of the hills, where the sand is least consolidated and protected and, by undercutting, in a few hours it may drift away immense quantities of sand, depositing it farther inland.

We noticed, in 1901, marked instances of this mode of action on the sides of some of the Tucker's Town dunes, where the wind had very recently cut perpendicular sections. Nearly the whole region about Tucker's Town is covered with this more or less loose sand, which extends about two miles along the shore; in many places it is becoming covered with vegetation, such as the sage-bush and blackberry (*Scævola*), etc. This district looks as if it had always been a barren, sandy region, but it is probable that in Governor Tucker's time (1616), when he had sugar cane and figs planted here, these sands had not invaded the district, and that the soil was fertile. The Tucker's Town lands are often mentioned by early writers as cultivated.

The early settlers made no mention of shifting sands, nor did they complain of the barrenness of the soil in the several places where active sand-dunes have prevailed in modern times.* Lieutenant Nelson, writing in 1837, says that the Tucker's Town sand-dunes were reported to have become active about 60 years previously, or about 1777.

Probably the cutting of the cedars and burning of the brush and vines to clear the lands, combined with the disturbance of the surface of the soil to build roads or in cultivating it, usually led to the activity of the destructive sands in these later times.

Norwood mentioned worthless sandy land as existing on Ireland Island, in his day, but not elsewhere, nor do we find any particular mention of any such drifting sands in the voluminous history of Governor Butler, 1612–24.

Lieutenant Nelson, in his account of the geology of the island, 1837–40, described active and extensive sand-dunes as existing at the time of his residence (1827–33), both at Elbow Bay and Tucker's

* In the "Orders and Constitutions" of the Bermuda Company, adopted in 1621, there was an allotment of a tract of public land, in these terms: "save that two hundred acres of the Iland called Davies Iland [Davids] shall be annexed to *Harrington* and *Hamilton's* Tribe, to make recompense for the alleaged sterility of the Land in that Tribe." (No. 107.)

This sterile land could not have been that of the Tucker's Town sand-hills, and the neck of land farther east, because the latter was, at that time, a part of the public land, not a part of either Tribe. It may have been the salt marshes and swamps that were referred to.

Town, and he gave a good history of the beginning of these invasions of sand. After discussing that near Elbow Bay (see under Geology), he gives the following account of this region:—

"There is another encroachment at Tucker's Town, said to have taken place about sixty years ago [about 1777]; and has crossed the neck between Harrington's Sound and the sea; but beyond this it does not seem inclined to move. The sand has not been stopped at the eastern extremity of the beach, where the bluffs commence, by their very considerable declivity,—though it has been most effectually at the crest of the slope, by a natural fence of sage bush, growing partly in the soil and partly in the sand; which, as it ascended, seems to have thus rolled on with the seeds of destruction to its progress, in its own bosom.

The same operations appear to have occurred throughout the sand tracts at and near Great Turtle Bay."

From this description it seems that the vegetation, at this very exposed place, has not been able to much more than hold its ground against the sand, but Nelson's account is too general to permit us to decide whether there has been any marked change in the extent of these dunes during the last 70 years. It would seem that there has not been any radical change in that period, though there may have been long periods of comparative rest.

Nelson also gives a more detailed account of the origin and progress of the sand dunes at Elbow Bay, which I shall discuss under the geology He states that it began on the land of a Mr. Lightbourne, in consequence of the cutting away the brush and disturbing the surface to build a fort and military road, about 1763. When he studied the dunes (1833) they were in very active progress and the sands had reached the height of 180 feet, but he observed that they were invariably stopped by a row of cedars, or by thickets of sage bush (*Lantana*).

Nelson also gives an account of an important change in the configuration of Shelly Bay, since 1804, due to the cutting of the brush on the sand-hills for fuel, and thus starting the sand to drifting, until the seaside sand-hills were swept away and thus permitted the invasion of the sea. (See plate lxviii, fig. 1.)

"In 1810 Shelly Bay scarcely existed; what is now the mouth, was at that time a row of sand hills, and the road on the north side lay close within. Some free blacks who lived there, being in want of fuel, cut down the plants which kept these sand-hills in a solid state. Being no longer duly opposed, the sea quickly broke through, and now retains possession of the ground at least 100 yards in rear of the

old road, traces of which are still visible. The Mangrove Swamp between the beach and the present road, was until then a garden."

The mangrove swamp referred to no longer exists. It has either filled up or there has been a farther encroachment of the sea, since 1833. (See under Geology.)

Without questioning the accuracy of Nelson's statement in regard to this bay, it should be noted that on Norwood's map of 1618–22, Shelly Bay is represented with very nearly its present size and form. This would indicate that the sand-hills described by Nelson had been formed subsequently to Norwood's survey, and that being of loose sand, when they were destroyed, after 1810, the original outline of the bay was simply restored. This bay is a very shallow, open, and exposed cove, facing north, with a wide sand-beach, and such changes would not be unlikely.

Probably the far greater activity of the sand-dunes in the time of the Greater Bermuda was due partly to more violent winds and larger areas of sea beaches, but there may have been a total lack of sand-binding vegetation at that time. (See Geology.)

The drifting sands have often buried and killed cedars and other trees in modern times, as described by Matthew Jones above.

When this occurs the rain-water trickling down the sides of the trunk, and perhaps along the roots, carries with it dissolved limestone (calcium bicarbonate), which it deposits in its course, and thus hardens the sand into a crust around the trunks and roots of the trees, so that when the wood decays a hollow mould is left, which may then be filled with loose sand, producing a cast of the trunk or roots of the trees.

Such casts, large and small, are common in the rocks of the islands at all levels, from below the sea to the highest hilltops, and they can be seen in actual process of formation. Many of them are thought to be the casts of stumps of palmettoes or some other palm tree, now extinct. (See under Geology and plates lxxxiv–vi.)

The drifting sands sometimes blow into the sea and accumulate in such quantities, in sheltered harbors, as to fill them up to a great extent. Tucker's Town harbor, originally called Stokes' Bay, which is now very shallow, with extensive sand-flats, bare at low tide, is said to have been deep enough, at first, to admit merchant ships of moderate size. Its appearance indicates that it is still filling up, for the upper part of the beach merges directly into the still active sand-dunes of the shore.

Mr. Nelson, also, says that before his time (1833) the channel at Crow Lane had been very much filled up, but this was probably by silt.

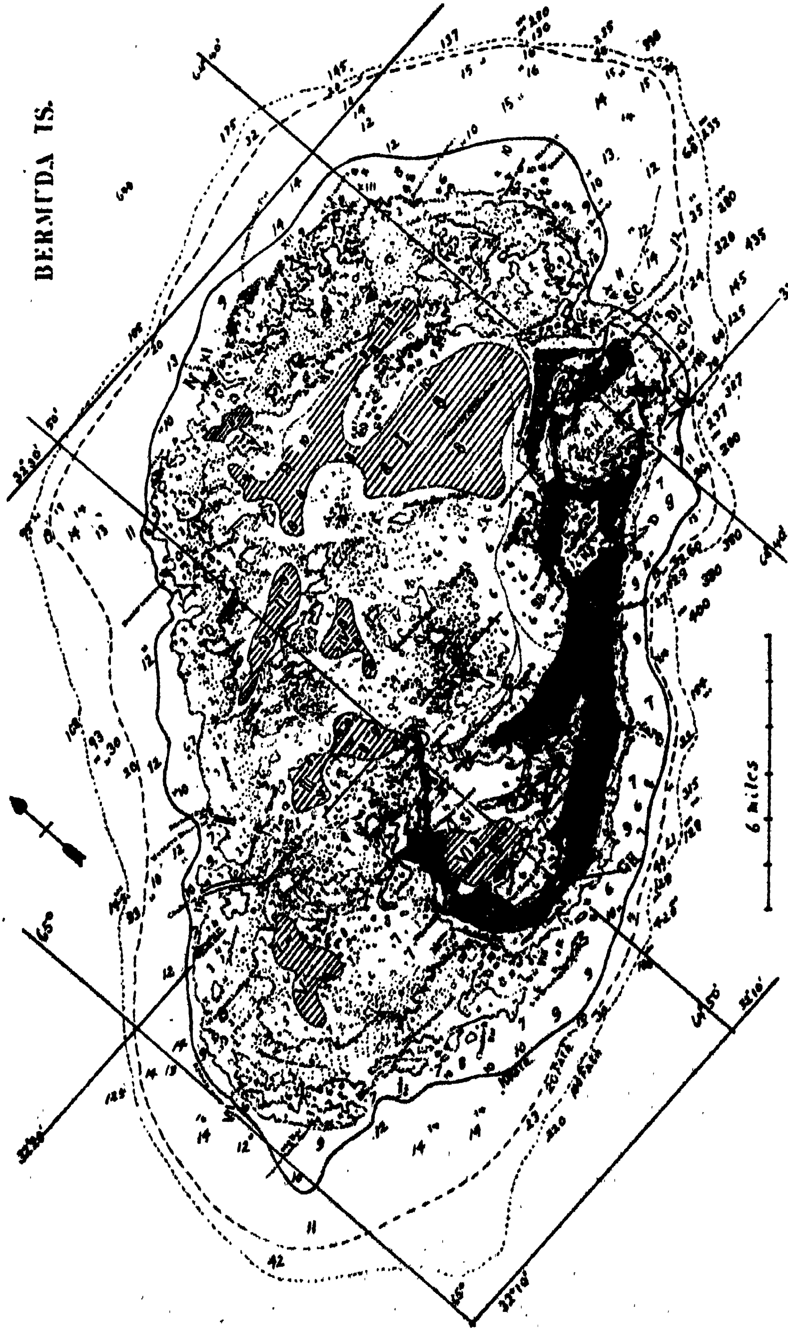

Figure 26.—Map of the Bermuda Islands and Reefs.

Explanation of Figure 26.

The depths outside the reefs and in the lagoons are in fathoms; those on the reefs and shallows are in feet.

I. I.—Ireland Island and Dry Dock.
BZ.—Boaz Island.
S. I.—Somerset Island.
B. I.—Bermuda or Main Island.
B.—Bailey Bay.
H.—Hamilton, the capital.
H. S.—Harrington Sound.
S. B.—Shelly Bay.
F.—Flatt's Village and the outlet of Harrington Sound.
E.—Elbow Bay, with modern sand dunes.
G. H.—Gibb's Hill Light.
D.—Devil's Hole.
C.—Causeway, destroyed Sept. 12, 1899, by a storm, and rebuilt
C. H.—Castle Harbor.
G. I.—St. George's Island and town.
G.—St. George's Harbor.
S. C.—Main Ship-channel or entrance to Murray Anchorage.
D. I.—David's Island and Light.
C. I.—Cooper's Island.
N. I.—Nonesuch Island.
K. I.—Castle Island and ruins of King's Castle.

The principal submerged sinks or drowned lagoons, over 50 feet deep, are shaded with parallel lines, and numbered I–VI. Their probable ancient outlets, called "cuts," are numbered VII to XV.

I.—Murray Anchorage.
II.—Blue Cut Sink.
III.—Sink north of Ireland Island, or Western Chub Cut sink.
IV.—Brackish Pond Sink.
V.—Chub Cut or Western Ledge Sink.
VI.—Great Sound Sink.
VII.—Cut in Long Bar, leading to a large passage 3 miles long and 6 to 7 fathoms deep, running S.E. and N.W. inside Long Bar Reef.
VIII.—Hog-fish Cut, 7–10 fathoms deep, leading to Chub Cut Sink, from the southwest.
IX.—Chub Cut, 3–8 fathoms deep, leading to Chub Cut Sink, from the north.

X.—Western Blue Cut, apparently partly roofed over by the reef, leading to Sink III.

XI.—North Rocks Northeastern Cut, leading toward a small sink 11 fathoms deep, not numbered (North Rocks Sink).

XII. and XIII.—Ledge Flat Cuts, 7–9 fathoms deep, connected together inside the outer reefs.

XIV.—Mills Breaker Cut, 8–10 fathoms deep, leading towards an irregular sink (not shaded) 9 to 14 fathoms deep, and about 2 miles long.

XV.—Main Ship-channel or the Narrows, a narrow, deep cut leading to Murray Anchorage.

NOTE.—The map is much altered from that of Agassiz by the addition of the three contour lines, at 10, 20, and 100 fathoms depths; by shading the deeper parts of the larger lagoons, where the depth exceeds 50 feet; and in some other respects. It is based on the Admiralty Chart, reduced by photography.

11.—*Anchorages or submerged Lagoons; Bottom Deposits.*

As stated on a previous page (p. 465), the area covered by the sub merged reefs and lagoons is more than ten times as great as the dry land. It has been estimated at from 200 to 230 square miles.

But of this whole amount a very considerable part consists of submerged lagoons, "sounds," or anchorages, nearly free of reefs over large areas, or often equal in area to Castle Harbor and Harrington Sound.

The more important of these are represented by the ruled areas (I to VI) on the map (fig. 26). One of the largest and best known is Murray Anchorage (I), just within the narrows. This is large enough for a large fleet of war vessels, and the bottom, in 7 to 9 fathoms, is of tenacious white mud.

The same white shell-mud and shell-sand are found over the bottoms of all these enclosed lagoons, at depths of 4 to 14 fathoms. In the deeper parts the mud prevails and often becomes very fine and tenacious. It is called chalky mud by the sailors, or simply "chalk." To the eye it appears to be almost entirely composed of a fine powder, but when washed through seives a considerable amount of shell-sand can almost always be separated, together with many small living mollusks, foraminifera, etc., but it is rather barren of life.

We dredged up large quantities of such mud at many localities in Great Sound, Bailey Bay, Murray Anchorage, Castle Harbor, and Harrington Sound. In all these places its nature was similar, only

differing in fineness and in the amount of small shells and shell-sand. It was not very profitable dredging, but the siftings yielded many small undescribed shells, annelids, etc.

On such white bottoms a very large black Holothurian (*Stichopus*) is very abundant. It becomes 15 to 18 inches long, and three or four broad. Associated with it are numerous large, nearly black or dark purple sea urchins (*Toxopneustes*). Both are conspicuous with a water-glass, on account of their dark colors. (See Part V.)

The bottoms of chalky mud make excellent anchorages, for it is said that vessels never drag their anchors in it, owing to its tenacity. It is related that a British sloop-of-war, the "Driver," once lost her bowsprit, while weathering a northerly gale in Murray Anchorage, by plunging it so deeply under water that she fouled it under her anchor cable, but yet did not drag the anchor.

12.—*The Reefs or "Flats"; North Rocks.*

The outer reefs form an almost continuous semioval boundary wall to the region of lagoons, for over 30 miles, from east of St. George's Island all around to and beyond the western end of the group. They are from half a mile to two miles or more in breadth and in most places are only slightly covered by water at low tide, so that the seas break heavily upon them, in long lines of white breakers in

Figure 27.—The Reefs or Flats near North Rock. Phot. December, 1875, by J. B. Heyl.

windy weather. In many places, as in the vicinity of the North Rocks, quite extensive areas of the flat reefs are laid bare by low tides. In other large areas the reefs are covered by from 1 foot to 8 feet of water at low tide. These reefs are very irregular in form,

and often broken up into distinct patches or groups, and small detached heads, with deep and narrow channels between them. These broad nearly level reefs are locally called "Flats." (Fig. 27.)

The four North Rocks, which stand on the platform of the outer reefs, about 8 miles north of St. George's Island, are the only points that are exposed at high tide. The largest of these is only about 12 or 13 feet high, above low tide, and about 7 feet in diameter (see figure 30). They are, like the reefs themselves, last remnants of what were once islands, now destroyed by the sea. (See map, fig. 26.)

These rocks are interesting historically, as well as geologically, for it was in close proximity to these that the "Bonaventura," with Henry May on board, was wrecked in 1593, as mentioned on another page, and so they were represented, with this wrecked vessel, on the reverse of the original seal of the Bermuda Company (see figure 29, ch. 23). They lie 12 miles N.N.W. from Catherine Point, at the eastern end of St. George's Island. Mills Breaker, which is dry at low water, lies 6 miles N.E. from Catherine Point. (See map, fig. 26.)

Within the outer reefs, and between the anchorages, there are innumerable detached reefs and groups of reefs of various sizes and shapes, but often covering many square miles, where the water is so obstructed and filled with reefs that no vessels of any kind can pass through them, except small boats in pleasant weather.

All these reefs are overgrown with corals of various kinds, sea-fans, serpulæ, mussels, sea-weeds, corallines, nullipores, and many other living organisms, which greatly protect them from the wear of the waves, and on the outer parts raise the level considerably above that of the underlying limestone rock. Were it not for this protective covering the reefs would be speedily worn away and destroyed.

Among the reef-corals that are most efficient, both in protecting and building up the surfaces of the reefs, are the "brain-corals" (*Mæandra*), the "star-corals" (*Orbicella* and *Siderastræa*); *Porites*; and the finger-coral (*Millepora alcicornis*). The latter is very abundant on all the reefs and rocks, including those near the shores, for it grows in very shallow water. It forms large and handsome masses of elegantly branched fronds, dark russet-brown in color when living. The common brain-coral (*M. labyrinthiformis*) is exceedingly abundant, and forms thick, rounded masses, sometimes 4 or 5 feet in diameter, orange yellow in life. The other brain-coral (*M. cerebrum*) forms similar masses, usually light yellow or greenish in color, chiefly on the outer reefs. (See Part V, and plates.)

The great star-coral, with star-shaped calicles about one-quarter or one-third of an inch across (*Orbicella cavernosa*), forms large solid hemispheres, but it only lives on the outer reefs. The smaller kind (*O. annularis*), with calicles about one-eight of an inch across, is also found chiefly on the outer reefs, but is more common. The *Sider-astræa radians*, which has crowded, shallow, confluent stars, about one-eighth of an inch across, is very abundant both in shallow water and on the reefs. It grows in solid, heavy, rounded masses up to a foot or more across. *Porites astreoides* forms irregular rounded and tubercular masses, up to two feet in diameter, covered with minute stars, about $\frac{1}{16}$ of an inch or less in diameter. It is usually dark yellowish brown when living. (See Part V.)

At the western end of the group the reefs cover a very extensive semicircular area, extending 7 to 9 miles from land, with a perfect labyrinth of broken and detached reefs, but more continuous toward their outer margins. This reef area is larger than all the dry land.

Figure 28.—Wreck Hill, as seen from the Sea, bearing N. $\frac{3}{4}$ East; after Findlay.

Among the most dangerous of these reefs are the Chub Heads, which lie 9 miles from the shore at Wreck Hill; Long Bar, of which the south part is 6 miles W.S.W. from Gibb's Hill Light; and Southwest Breaker, on which the sea always breaks, and which lies $1\frac{1}{4}$ miles from the shore, and about south from Wreck Hill, which is a rather conical high hill, standing detached from the other hills, at the extreme western end of the main island. When seen from the sea it appears dark colored. From the southwest it appears flattened at the top, but from the south it is conical. It is usually the first land made in approaching the islands from the westward. (Fig. 28.) The modern sand-dunes in the region of Elbow Bay, East of Gibb's Hill Light, are conspicuous at sea, from a long distance, by reason of their white color, and are called the Sand Hills.

13.—*Serpuline Atolls or "Boilers."*

Along nearly the whole southern shore of the islands the reefs are situated much nearer to the shore. Most of them are not more than half a mile away, though in some places they may be nearly a mile from the shore. Along this coast most of them have taken on a peculiar form known as "boilers" or serpuline atolls (See plates lxxvii–viii.)

These are detached, rounded, elliptical, or irregular reefs with a raised rim and excavated or cup-shaped central part. They vary in size from those only a few feet in diameter up to those of 100 feet or more Many are very regularly rounded The rim is formed by a solid, raised, living crust, made up of the hard convoluted tubes of serpulæ and *Vermetus*, barnacles, small black mussels, nullipores, corallines, and some true incrusting corals, such as *Porites astreoides*, and a few others. Usually the living rim rises from 1 to 2 feet above low-tide level, because the serpulæ and mussels, of which it largely consists, can endure an exposure to the air of an hour or two, without inconvenience. But they soon reach their limit of endurance in this respect, and stop growing upward. (See Geology.)

The seas, even in moderate weather, always break on such reefs, forming a line of outer white breakers nearly parallel with the shore.

There is also, in many places, as near Hungry Bay, an inner line of these "boilers" of the same structure and form, very near the shore, and sometimes even united to the shore ledges at some points.

These "boilers" are fundamentally of the same structure as the other reefs, for beneath the marginal crust of serpulæ, etc., they consist of æolian limestone, like all the rest.

Their hollow or cup-shaped form is due to the heavy seas that dash against the hard outer rim and fall over into the unprotected central area like a cataract, rapidly wearing off and carrying away the soft rock.

Reefs having this character, in so perfect a form, have not been observed in any other part of the world.

14.—*Channels or Natural Cuts through the Reefs.*

There are, besides the main ship-channel or "narrows," several other channels or "cuts" through the outer reefs on the eastern, northern, and western sides, through which vessels of small size can reach the anchorages and harbors, if they have a good local pilot and favorable winds. Some of these were formerly considerably

used by commercial vessels; especially Hog-fish Cut, for reaching Elies Bay, or harbor; some of them are still used by the fishermen.

No doubt some of these could easily be improved and made into safe channels for large vessels, if the British government thought it expedient to do so.

These channels have a special interest in connection with the geology of the islands, and will, therefore, be discussed under Geology; most of them are shown on the map, (fig. 26, p. 480). Some of them, which are not indicated on the Admiralty Charts as extending through the reefs at all, are described by others as passable for vessels, though narrow and irregular. Therefore I have thought it best to quote the descriptions of most of them from another work. On the map (fig. 26) the cuts are indicated by the Roman numerals, VII–XV.

The most important one is the main ship-channel, which is situated at the eastern end of the reefs and near the northeastern end of St. George's Island. It is sufficiently deep for large naval vessels, but is narrow and crooked. It is, however, very carefully buoyed. (See map, fig. 26, S. C. and p. 418).

In this place it will best serve my purpose to quote the descriptions of most of the others, printed with his sailing directions, by A. G. Findlay, 1870, who had personally examined them.*

"Proceeding northward, the next channel is *Mills' Breaker Channel*, the entrance to which is half a mile North of the Mills' Breaker. Its direction inwards is S.W. towards the Narrows, and is only used by Bermudian vessels in and out. (Fig. 26, XIV.)

Continuing in the same direction, the north-eastern face of the reef presents an impenetrable and continuous reef, often breaking, until we come to the *North Rock Channels*, having a southerly direction. [North Rocks are at N., on fig. 26.]

There are two channels by the North Rock; that on the eastern side of the Rock is called the Northeast, and the western, the Northwest Channel.†

* These descriptions are essentially the same in the various editions, down to the 15th, in 1895, but with some verbal changes.

† No passages through the reefs are indicated at the positions of either of these two channels on the U. S. Hydrographic Office chart of 1877, corrected to April, 1900, and based on the "most recent British Admiralty Surveys" (1874 and later). On the margin it is mentioned that extensive corrections were made in 1895 and 1897.

On that chart the outer parts of both cuts are indicated, as penetrating the reefs, but the inner portions are shown completely interrupted and blocked by

They are known only to a few of the pilots, and from that cause but seldom used, although it is said that the North-eastern channel is one of the best through the edge of the reef. Fig. 26, XI. The North-eastern channel is narrow and intricate at its entrance; the general depth is 6, 7, and 8 fathoms; but in one spot but 5. At 5½ miles in the direct line from the entrance, toward Murray Anchorage, there lies a cluster of rocks, which renders a circuit to the westward advisable. The mark for clearing the West end of these, the *Three Hill Shoals*, is Painter's Hill, over a hill on the western side of the Ferry at St. George's Island, bearing S.S.E. There is also a channel through the shoals, which is more direct, the mark for which is Painter's Hill in the hollow or saddle of two hills (hence their name), at the West end of St. George's Island, bearing S. ¼ E. As soon as the shoals are cleared in either case, which will be when 3½ miles from the shore, you can bear round to the S.E. to Murray Anchorage, this part of the reef being clear. (Fig. 26, I.)

The next is the *Blue Cut*, on the western side of the reef, but can be used only by small vessels. It is exceedingly narrow and intricate, and has only 8 feet water in places. Its direction is to the East of South. (Fig. 26, X.)

The *Chub Cut* is the next channel southward; this is also narrow and dangerous. It leads southerly to Wreck Hill, or first southerly and then easterly to Ireland Island. (Fig. 26, IX.)

Hog Fish Cut lies at the south-western angle of the islands. For half a mile in a north-easterly direction it lies through numerous rocky shoals, and then turns to the N.W. It leads to Ireland Island and to Elies Harbour.* (Fig. 26, VIII.)

The Hog Fish Cut, which has recently been examined with a view to its improvement, is the most convenient at the West end of the islands, particularly in the winter season, when the winds prevail at N.W., and the danger of being at sea and about the islands is the greatest.

the shallow reefs, indicated by shading and crosses. Whether marked natural changes have occurred since 1870, I cannot say, but it seems very doubtful. Perhaps it was not deemed expedient to indicate these channels, as they actually exist, owing to their intricacy and dangers, or for strategic reasons. That such channels are generally filling up with mud at the bottom, and by the growth of the corals on the sides is very certain, but such changes are so slow that in a period of 30 or 40 years we should not expect them to be very evident. The Northwest channel is not indicated on fig. 26.

* Elies Harbor was named for Mr. William Eli, who was settled on its shore in 1621. The name is sometimes erroneously written "Ellis."

The Hog Fish Cut, though not far from the land, is an entrance from the ocean, through the outer barrier of rocks. Before arriving at the Cut there are the *Bream Shoals*, to be carefully avoided. The course through what are called the Chops of the Cut is nearly at a right angle; the turn is very sudden and sharp, and the greatest nicety must be observed by the pilots in navigating it. The course in from the ocean to Hog Fish Cut is N.E., and from the Cut to the *Kitchen Shoals* N.W.; and the passage is so narrow that it does not afford sufficient space for the vessels to tack in, and when a passage through them shall be attempted, it must be without a change of tack. These difficulties are felt more especially in the winter season, when the winds are generally unfavourable for passing the Kitchen Shoals. To remedy this evil, the committee appointed for the purpose (August, 1846) recommended the removal of the centre Kitchen Shoal, of coral (8 feet on it at high water), by the same means employed at St. George's Harbor, when a passage sufficiently capacious would be opened, and vessels, now often compelled to remain at sea, or make the circuit of the island in search of shelter, would find an easy and ready access to port.

The various channels here mentioned, having different directions, are available according to the wind, that which is fair for one being the reverse for others; but they must not be attempted without a pilot, who will immediately come off from St. David's Head, upon a signal being given to that effect; and a vessel in the offing requiring a pilot, it is telegraphed from one part of the island to the other They will be best understood by referring to the Chart of these islands.*

The south-eastern face of the reef forms nearly a continuous line of breakers, about 2 cables' lengths from the shore, and has no entrance or shelter till we come to *Castle Harbour*, the entrance to which, past the King's Castle, is in a N.W. direction. (Fig. 26, KI.) There is no other opening through the reef between this and the channel under St. David's Head, before described."

15.—*Tides and Currents.*

The tides vary to a considerable extent according to the force and direction of the wind, and the same is true of the variable currents

* A Chart of the Bermudas or Somers' Islands, with Plans of the Narrows and Murray Anchorage, and St. George's Harbour, &c., by A. G. Findlay, F.R.G.S., published by Mr. R. H. Laurie, London, 1870, accompanied by a description of the islands.

between the reefs. Ordinary tides rise from $3\frac{1}{2}$ to 4 feet, but the spring tides may rise 5 feet, and in gales of wind sometimes 7 feet. In Harrington Sound there is usually only 6 to 8 inches of tide, seldom a foot. Near the shores the tidal currents run in various directions, often varying according to the winds.

In 1666, the Royal Society of London (founded in 1662) sent to Mr. Richard Norwood, the surveyor, a long series of questions concerning these islands and their productions, whale fishing, etc. Many of these were answered in a letter from Mr. Richard Stafford (later Judge Stafford), July 16, 1668. Mr. Norwood replied to the questions concerning the moon and tides, in a letter of June 18, 1667. Both letters were published in the Philosophical Transactions, vols. II, III.

In his letter Mr. Norwood gives several facts as to the tides. He stated that the tides commonly rise 4 feet, at spring tide 5 feet, but that they are variable according to the wind; in calm weather the flood tide sets from the southeast; high water occurs at 7 o'clock on the "change day."

16.—*The Soil; its Origin and Composition.*

With the exception of the black peat or muck of the swamps and marshes, all of the soil of the islands has been produced as an insoluble residue, or impurity, left after the solution of the limestones and shell-sands of the islands by rain water, but it is usually mixed with more or less disintegrated limestone, and some organic matter.

These rocks and sands always contain a small amount of earthy impurities, often not more than 0.5 of one per cent., and seldom more than one per cent., which consists mainly of clay and iron oxide, and with a little phosphate of lime, potash, etc., to which the soil owes its fertility.

This process of forming soil is a very slow one, and indicates, as well as anything else, the long period of time that has elapsed since the Bermudas became dry land. The average thickness of this soil has been variously estimated at from one to two feet, which would require the destruction of at least 100 to 200 feet of limestone. (See under Geology.)

Where the decomposition has been complete, this soil is a reddish clay, the color being due to an excess of iron oxide, but in most places the clay soil is mixed with considerable shell-sand, or grains of undecomposed rock. In many places the latter forms the greater

part of the bulk. In some sections of the limestone rocks, as many as five to seven buried layers of red clay, generally thin, may be seen, indicating as many successive periods of surface decomposition, each of pretty long duration.

The mixed soils are the better, and when they contain vegetable mould they are often remarkably fertile.

There is ample evidence that the original virgin soil of Bermuda was wonderfully fertile.* Tobacco and corn were the principal crops for nearly a hundred years, and both are notoriously exhaustive to soils, especially the tobacco, which requires much potash. (See Part III, Tobacco.)

Large amounts of tobacco were exported for 80 years,—sometimes as much as 200,000 pounds annually, but we find no record of any artificial fertilizers having been used during that time,† and as but few cattle were kept, there could have been but little manure used. Probably seaweeds were used to some extent, as now. The burning of the cedars and brush would have furnished some potash to the soil for a time, but not for any long period. There could have been but little rotation of crops. Therefore, it is very remarkable that any decent crops could have been raised on the same ground during all that time, and ever since, in many cases.

Capt. John Smith, in his General History, ed of 1629, said that the fertility in some places had decayed "and in many places decayeth." There is abundant positive evidence that the soil did become very badly exhausted in many places, and the crops depreciated greatly in the 18th century. From 1700 to 1840 agriculture was not

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* The Rev. Mr. Hughes, in his letter of 1614, speaks of their raising two crops of wheat each year, and adds the following as to the fertility of the soil, etc :— "The earth is very fertile, and so mellow and gentle, as it needeth neither plowing, nor digging, so that after the wood is taken off, and the grasse and weeds bee burnt and destroyed, and the common business of Fortifying bee once ended, men shall live heere in much ease, without such moyling and toyling as in England, The greatest labour will be worming and pruning of some plants, which children may doe as well, and better than men."

"I wish that all they that hereafter shal come hither out of England would consider with themselves that these Ilands were never inhabited till now, and that therefore they must of necessity labour hard at first, and be contented to endure hardnes and some want of many necessaries."

By "wheat" he probably meant maize, as is plainly indicated in other passages of his writings. Real wheat does not flourish in Bermuda.

† True artificial fertilizers, in the modern sense, were then unknown, but in New England, at that time, it was customary to use fish and fish refuse, as well as wood ashes, for fertilizers.

prosperous, but that was due partly to social and commercial conditions. At the present time the soil, in spite of the modern use of fertilizers, is probable much less fertile, in most places, than the original virgin soil. Nevertheless, the soil in some districts is still wonderfully productive. There is no evidence of any change in the climate, but quite the contrary. Still it is doubtful if pineapples could be raised there in such abundance, and of so good a quality as they were in 1620 to 1650.

The lack of the shelter from the bleak salt winds, furnished at first by the cedars, would account for some of the change, but the exhaustion of the vegetable mould, potash, and phosphates in the soil was probably the main cause.

Even now, many planters take far more of such essential materials from the soil than they give back to it, for they expect to raise two or three crops each year on the same ground, with perhaps only one very scanty supply of fertilizers

The very primitive and imperfect methods of cultivation practiced for over 200 years render it still more remarkable that they could have raised as much as they did. Up to about 1829, the common plough was almost unknown in Bermuda. All the cultivation was done with the hoe, and mostly by slaves. It was, of course, a very shallow cultivation, carried on with no scientific knowledge.

Under these circumstances a study of the composition of the natural soils of Bermuda, and especially of the red clay, becomes of much interest. The red clay contains a notable quantity of phosphates.

At the present time a liberal amount of fertilizers is used by many of the more enterprising planters, with marked success. In 1901, 2636 acres were under cultivation, according to the census returns.

17.—*Analyses of Bermuda Soils.*

Governor Lefroy has given the results of several analyses, which are as follows :—

The following Analyses of Bermuda Soils have been adapted from those Published by Governor Lefroy.*

	White Soil.		Red Soils.							
	Manning.				Manning.					
	No. 1. Sand.	No. 2. Mud.	Prof. Bernays.	Prof. Abel.	No. 3. Soluble.	No. 3. Insol.	No. 4. Soluble.	No. 4. Insol.	No. 5. Soluble.	No. 5. Insol.
Water (not included)	0.316	18.134	18 7	42.57	16.231	-----	6.930	-----	23.20	-----
Organic substance	3.816	4.700	-----	-----	13.280	-----	16.260	-----	16.710	-----
Calcium Oxide	52.47	51.400	-----	5.59	3.724	0.431	1.250	2.386	10.077	-----
Calcium Carbonate	-----	-----	4.31	-----	-----	-----	-----	-----	-----	-----
Calcium Sulphate	-----	-----	2.50	-----	-----	-----	-----	-----	-----	-----
Magnesium Carbonate	1.686	0.756	3.32	3.50	0.018	0.530	0.099	-----	0.199	0.217
Alumina	-----	-----	-----	20.44	0.173	16.155	0.120	24.850	0.105	9.474
Sand and insoluble clay	0.030	0.047	-----	48.70	-----	47.380	-----	21.910	-----	40.670
Silica	-----	-----	45.74	-----	0.149	-----	0.037	-----	0.159	-----
Iron Oxide and Alumina	0.520	0.213	43.67	13.29	0.047	14.580	0.362	30.880	0.046	12.840
Potash	0.064	0.088	-----	-----	-----	0.140	-----	0.169	-----	0.113
Soda	0 243	0.070	-----	-----	-----	0.007	-----	0.060	-----	0.033
Carbonic Acid	42.866	42.580	-----	5.55	2.666	-----	0.836	-----	8.676	-----
Sulphuric Acid	0.206	-----	-----	-----	trace	-----	0.065	-----	0.040	-----
Phosphoric Acid	0.077	0.124	-----	2.93	-----	0.742	-----	0.676	-----	0.681
Chlorine	0.020	0.011	-----	-----	-----	-----	0.046	-----	-----	-----
Chlorides, Phosphates, etc., not determined	-----	-----	1.06	-----	-----	-----	-----	-----	-----	-----
					20.058	79.945	19.075	80.931	36.012	64.030
	102 01	99.99	100.0	100.00	100.0		100.0		100.00	

* Royal Gazette, Hamilton, 1883. (Reprinted in Bull. U. S. Nat. Mus., No. 25, p. 37, 1884.)

The numbered samples of soil in the accompanying table came from the following places:

The samples of soil forwarded to Mr. Manning for analysis were as follows:—

No. 1.—Pure white sand taken from the bottom of the hill on the Pembroke marsh side of Mount Langton.

No. 2.—A chalky mud, which occurs in a vein in the same locality.

No. 3.—Pure virgin red earth from the layer on the east side of Bishop street, Hamilton, about 60 feet above the sea.

No. 4.—Good average agricultural red soil, taken from a field on the Devonshire College ground, which at the time was under tomatoes.

No 5.—Very red soil from Mr. Gibbons' farm near the Causeway, under arrowroot at the time.

There can scarcely be a doubt that with so good a soil as a foundation, and with so favorable a climate, immense crops could be grown by the modern scientific methods of intensive culture and abundant use of the proper fertilizers, adapted to any required crop. It would seem probable that the culture of a high grade of tobacco, on modern scientific principles, and under cloth frames,* could be made very profitable.

18.—*The Climate.*

The tables printed below will give a fairly good idea of the climate, as observed during a series of years. The principal peculiarities are due to the insular situation and the proximity of the Gulf Stream. Both these factors tend to prevent extremes of temperature and sudden changes. But the temperature and dampness of the air vary greatly according to the direction of the wind, especially in winter. The northerly winds are usually cold and chilly, and are often accompanied by cold rains, but at other times by cool and dry weather. But southerly and southwesterly winds from over the Gulf Stream are warm and damp; they are the prevailing winds in summer, and usually, also, in the winter and spring, but northerly winds are often nearly as frequent in winter. Fogs, however, are of very rare occurrence.

The average temperature during the three winter months and March is from 63° to 66° F.; April, about 65°.5; May, 70°.5; June,

* In early times the tobacco crop was often much damaged, or nearly destroyed, by blighting winds, probably due largely to the salt spray in most cases. The use of thin cloth shelters, which has been found so advantageous in this country, especially in Connecticut, would be worth trying in Bermuda.

76°; July, 80°; August, 81°.7; Sept., 80°; Oct., 73°.7; Nov., 68°. The average for the year is about 70° F., but ranges from 69° 5 to 70°.5. But temperatures as low as 50° to 53° are not uncommon in winter; 42° is rarely reached. It is rarely as high as 87° in summer, but the mean relative humidity, during the summer months, ranges from 80 to 91.

a.—*Rainfall; Hail; Thunderstorms; Fogs; Moisture.*

The amount of rainfall is large, and it seems to be somewhat larger at Hamilton and Ireland Island than at St. George's. According to Lefroy's tables, covering eleven and sixteen years, respectively, it was 54.66 inches at Ireland Island and 48.61 inches at St. George's. The amount near Hamilton in later years usually varied between 58 and 63 inches, but in 1898 was only 48.19, and in 1900 it was 67.05 inches. (See Tables, pp. 500–502.)

The rainfall is usually pretty well distributed throughout the year, but is generally greatest in October and November and least in the summer months, when droughts are not uncommon, but seldom very prolonged. Usually more or less rain falls on from one hundred and ninety to two hundred and seven days; and on at least half of the days of all the months from November to April.* But in many cases the rains are mere showers of very brief duration.

Fogs are of rare occurrence, but really dense fogs are scarcely known about the Bermudas, so that vessels rarely if ever get ashore on that account. We observed land fogs in the early morning, several times in March; sometimes it was somewhat dense, but it soon passed away.

The air is, for the greater part of the time, decidedly moist, as shown by the tables below, and in the summer time it is often nearly saturated with moisture, so that it is very oppressive to many persons.

Several rather severe hailstorms have been recorded, but they are not at all common.† Strachy records that in 1609:—"In the beginning of December wee had great store of hayle." Lefroy says that on Feb. 20, 1872, "the ground was in some places white with hail, which did not disappear for some hours."

* Owing to the amount of rainy weather in the cooler months, and the moisture of the air generally, the climate of Bermuda is not well suited for many invalids who go there. For consumptive patients, especially, who usually need a dry climate, the conditions are not favorable. For nervous diseases it seems to be excellent.

† According to the New York papers a hailstorm occurred at Bermuda, April 21, 1902.

Thunder showers are very common, and they occur in all months of the year, but they are usually of short duration, though sometimes very violent.

b.—Winds; Hurricanes; Gales.

The climate must be considered as decidedly windy, as the tables will show. Perfectly calm days are of rare occurrence, except during the summer months, when there will sometimes be several perfectly calm days in succession, but a few nearly calm days usually occur in each month. The mean annual velocity is eight to nine miles per hour. Strong gales and severe storms are not uncommon in the cooler months, from November to April, but the very destructive cyclonic hurricanes that have occasionally visited the islands, generally occur in August or September, more rarely in October and November.

One of the most violent hurricanes on record occurred in the night, Sept. 12, 1899. This did very great damage to the trees and to property, but no lives were lost. It carried away most of the long stone causeway from the Main Island to St. George's, and greatly damaged the wharves and buildings at St. George's. It also did great damage to the causeway and other works at Ireland Island, and at other places at that end of the islands. (See p. 442.)

Another hurricane of nearly the same character, and perhaps of even greater violence, visited the islands just 60 years earlier, on Sept. 11 and 12, 1839. That storm also did great damage by uprooting large numbers of trees and unroofing and blowing down houses. Similar hurricanes are several times recorded in the early settlement of Bermuda.

One in Governor Moore's time, 1612, blew down his framed church and did other damage. A severe storm is mentioned in 1615.

Captain John Smith stated that in the last of November, 1619, there was a "terrible Hericano" which "blew up great trees by the roots." The magazine ship "Warwick" was wrecked in the harbor,* and the "Garland" was only saved by cutting away her masts. A little later in the same season there was another similar storm which blew down the new lookout tower and blasted the entire crop of corn.

* The Rev. Mr. Hughes in 1620 referred to this wreck as follows: "Consider also the goodnes of God in preserving all shippes belonging to these Ilands so as none have beene cast away neither going nor coming: true it is that this last yeare 1619 a ship was cast away, not going nor coming, but riding at anker in the harbour."

Aug. 16, 1629, there was só great a storm that the governor and council the next year (1630) ordained a proclamation, setting aside its anniversary as a day of thanksgiving and prayer. In Governor Roger Wood's proclamation, he said that although the Lord had seen fit to destroy their houses and crops, he had spared their lives.

In the order of the governor and council it is mentioned that:

"Their buildings and croppes in generall were utterly ruinated by the saide guste, without taking away the life of any man, woeman or childe, which ought never to bee forgotten."

It was also ordered that the public buildings then blown down should be repaired as soon as possible, namely:—the Courte of Guard; the Prison; Warwick Fort; and Pembroke Fort.

The ship "Virginia Merchant" was cast away on the south coast, in a severe storm, March 24, 1661, and 170 lives were lost.

In October, 1780, there was also one of the severest hurricanes ever recorded there. Houses were blown down and cedars were torn up by the roots. The tide rose to a great height and much damage and loss to shipping occurred.

On Monday night and Tuesday morning, Feb. 16 and 17, 1784, according to the Royal Gazette, there was a heavy storm; trees were torn up; houses damaged; boats lost and destroyed. The Assembly of the Island, which was to have met at St. George's, could not come out of the country on account of the storm.

The Bermuda squalls or gales are sudden and violent tempests, occurring particularly in the winter season. Findlay described these gales as follows:

"As the day closes, the whole horizon becomes obscured by dark and heavy clouds, and the thunder and lightning, which precede the first squall, give notice of its approach. After the commencement, the wind, continually shifting, blows in tremendous gusts at intervals of every 20 or 30 minutes, a dead calm intervening; and the sea, rising in confused and breaking waves, renders the situation of a vessel, particularly a small one, very dangerous.

The conduct pursued by seamen, and which appears to be the most advisable under such circumstances, is to furl the ship's sails, and endeavour to get before the wind; by which means she may ultimately run clear of these local squalls into a steady breeze."

A local tornado is recorded as having occurred at Tucker's Town in 1875. It destroyed a small dwelling house and carried the occupants some distance, injuring the owner and killing his wife and children. Storms of this character appear to be rare in Bermuda.

c.—Temperature; Frost, Ice, and Snow.

Frosts have been recorded only a few times during the whole period of the history of the islands, and in those cases they have been light and probably local. No great damage, even to tender plants, has ever been recorded as caused by frosts.

Governor Lefroy cites two authentic cases: Dec. 24, 1840, when ice was formed in tubs, in low situations, "to the thickness of a half-crown," and vegetation was considerably damaged, according to some writers; and Feb. 21, 1878, when the thermometer on grass registered 28°.2 F.

A few scattering flakes of snow have been seen in a few instances, but so rarely that it is regarded as a remarkable event. On March 1, 1784, at St. George's, according to the Royal Gazette, "A light flight of snow fell here. In a house the thermometer was as low as 48°, out of doors 44°." One instance was in 1811 or 1812; another, March 4, 1874.

There is no evidence of any definite change in the climate since the islands were first settled. Jourdan's description, in 1610, would still apply very well:—

"In August, September, and untill the end of October, wee had very hot and pleasant weather, onely (as I say) thunder, lightning, and many scattering showers of Raine (which would passe swiftly over, and yet fall with such force and darknesse for the time as if it would never bee cleere againe) wee wanted not any: and of raine more in Summer then in Winter, and in the beginning of December wee had great store of hayle (the sharpe windes blowing Northerly) but it continued not, and to say truth, it is wintry or summer weather there, according as those North and North-west windes blow. Much taste of this kind of Winter wee had; for those cold windes would suddenly alter the ayre: but when there was no breath of wind to bring the moyst ayre out of the Seas, from the North and North-west, wee were rather weary of the heate, then pinched with the extreamitie of cold: Yet the three Winter moneths, December, January, and February, the winds kept in those cold corners, and indeed then it was heavy and melancholy being there, nor were the winds more rough in March, then in the aforesaid moneths, and yet even then would the Birds breed. I thinke they bredde there most monethes in the yeere, in September, and at Christmasse I saw young Birds,* and in Februarie, at which time the mornings are there (as in May in England) fresh and sharpe."

* The "cahows" bred in December and January according to all the early accounts.

According to Governor Lefroy the lowest records of temperature are most apt to occur in March. He states that in the years 1872–77, a thermometer on grass registered below 40°, 17 times, viz.:—December, twice; January, four times; February, three times; March, eight times. The lowest was 34°, in January, 1874; the lowest in March was 35°, in 1877.

Table of Mean Monthly Temperatures and Rainfall.

The following table is copied from Governor Lefroy's work on the Botany of Bermuda:

CONDITIONS OF TEMPERATURE AND RAINFALL AFFECTING VEGETATION IN BERMUDA *

	Temperature of the air.		Temperature of the soil:		Mean rainfall. Inches.
	9 A.M.	3 P.M	at 6 Ins.	at 12 Ins.	
	°	°	°	°	*In.*
January	64.0	65.5	62.0	62.5	3.8
February	63.7	65.1	61.1	61.4	4.2
March	63 8	65.5	61.5	61.5	3.6
April	67.4	69.3	64.8	64.9	3.3
May	72.0	73.5	69.9	69.5	4.1
June	76.8	78.8	74.5	73.9	3.3
July	81 3	82.9	78.3	77.9	4.0
August	82.5	84.2	79.1	79.2	3.9
September	80.2	81.9	77.1	76.9	4.8
October	75.5	76.7	73.4	73.7	6.7
November	69.8	71.1	67.2	68.1	5.7
December	65.4	66.4	62.9	63.2	4.0
	71.9	73.4	69.3	69.4	51 4

The mean annual temperatures of the air during 22 years was 71°.9 at 9 A. M., and 73°.4 at 3 P. M.

The mean temperature of the soil at the depth of 12 inches was 69.°4, which is probably very close to the true mean annual temperature. He gives the average annual rainfall, for the same period, as 51.4 inches.

* The mean temperatures are given by observations extending (with some lacunæ) from August, 1855, to March, 1877. The temperature of the soil at 6 inches is the mean between observations at 9 A.M. and 5 P.M., apparently the hours of extreme daily range. The temperature at 12 inches is that at 9 A.M.; the daily range at this depth is under 0°.5, and is about the mean at 9 A.M.

d.—Meteorological Tables.

METEOROLOGICAL OBSERVATIONS, BERMUDA, 1898.

Observatory, Prospect Hill, Latitude 32° 17' 40" North; Longitude 64° 47 00" West. Elevation 151 feet above sea level.

Observations taken daily at 8.41 A. M. and 8.41 P. M., by E. J. HARRIS, Corporal, Royal Army Medical Corps.

Month.	Temperature of the air. Mean.	Highest.	Lowest.	Daily Range. Mean.	Daily Range. Greatest.	Relative Humidity Mean.	Relative Humidity Lowest.	Mean cloudiness.	Days completely clouded.	Wind Number of observations from: North.	Northeast.	East	Southeast.	South.	Southwest.	West	Northwest.	Calm.	Velocity of wind. Mean miles per hour.	Highest days velocity per hour	Direction and date.		Precipitation. Amount.	No. of days on which rain fell.	Highest amount in any day.	Thunderstorms	No of gales	Month.
January	62.8	73.1	49.2	9.6	15 5	77 0	56 3	.6	5	4	2	1	1	7	7	11	11	18	9.6	24 2	N.W	27	3.87	21	1 27	1	1	January.
February	62.4	71.9	51.0	8.8	16 3	76 4	58.5	.6	6	13	2	1	1	6	3	5	9	16	9.7	31 9	N.	9	3 89	15	1 31	1	0	February.
March	63.5	73.5	50.0	8.8	17.3	74 5	50.9	.7	7	18	16	0	4	4	1	9	2	8	12.6	22.9	N E	26	1.19	13	69	0	0	March.
April	65.0	76.9	50.8	10.6	18.9	82.2	59 5	.6	8	2	1	0	0	16	12	8	7	14	10.8	24.3	W	3	8 53	18	1 80	1	0	April
May	68.2	81.2	51.8	10.8	15.7	79.0	57 8	6	5	7	4	1	4	6	6	10	10	14	8.9	15 1	S	8	2 15	16	56	1	0	May
June	74.1	82.9	64.8	10.9	15.5	80.9	57.4	6	4	8	2	0	3	3	21	4	7	17	5.9	11 6	S W.	3	7 32	19	1 33	3	0	June
July	79.4	87.5	69.2	11.2	14 7	79.2	60 5	5	2	6	4	5	3	4	11	2	3	24	4 6	8 6	S.W.	16	2.72	18	.54	0	0	July
August	81.1	90.3	72.0	11.9	15.9	77.9	66.7	.5	0	7	2	0	10	3	9	2	0	29	3.4	10.4	N	2	5 79	20	1.48	1	0	August.
September	79.8	88.7	69.2	10.5	15.9	77.9	62.1	.6	5	8	6	3	6	8	11	1	1	16	5.7	20.3	S.W.	18	3.32	18	1 02	3	0	September
October	75.0	84.3	65.4	9.2	17.5	77.0	54 4	.5	6	5	7	13	8	3	13	0	0	13	8.0	14.9	S.W.	31	4.24	13	1.62	0	0	October.
November	67.9	79.5	55.0	8.8	13.5	70.2	50 5	.5	8	8	17	1	3	3	9	5	7	7	11.1	19 4	S.W	30	3.69	17	1.06	1	0	November.
December	65.4	75.3	54.4	8.7	14.1	76.9	56 2	6	6	8	4	1	9	6	11	5	7	11	7.9	15 8	S.W.	14	1.48	19	.43	0	0	December.

Mean atmospheric pressure for the year......	30.114	inches.
Mean temperature of the air for the year	70.4	degrees.
Mean relative humidity for the year..........	77.4	per cent.
Mean hourly velocity of wind for the year....	8.2	miles.

Total amount of rainfall for the year	48.19 inches.
Difference of rainfall from average of the past eight years..........................	14 62 inches less.
Rain fell on 207 days during the year.	

METEOROLOGICAL OBSERVATIONS, BERMUDA, 1899.

Observatory, Prospect Hill, Latitude 32° 17' 40" North; Longitude 64° 47' 00" West Elevation 151 feet above sea level

Observations taken daily at 8.41 A. M. and 8.41 P. M., by E. J Harris, Sergeant, Royal Army Medical Corps.

Month.	Temperature of the air. Mean.	Highest.	Lowest.	Daily Range. Mean.	Daily Range. Greatest	Relative Humidity Mean.	Relative Humidity Lowest.	Mean cloudiness	Days completely clouded	Wind. Number of observations from. North.	Northeast.	East	Southeast.	South.	Southwest.	West.	Northwest.	Calm.	Velocity of wind. Mean miles per hour	Highest days velocity per hour	Direction and date	Precipitation. Amount.	No. of days on which rain fell.	Highest amount in any day	Thunderstorms.	No. of gales.	Month.
January	63.8	72.9	50.6	9 8	14 7	80.9	54.2	6	3	7	8	2	4	3	20	0	6	12	8.9	17 5	N.E. -3	5.90	24	1 22	0	0	January
February	64.2	75 1	52.4	8.8	15.9	78 0	58.9	6	2	5	6	0	2	3	21	5	8	6	10.6	26 2	W -14	3 29	13	1 01	0	1	February
March	64.4	75 3	53.2	10 9	19.3	74.1	48.8	5	2	8	9	0	8	4	18	4	6	5	9 8	18 5	W -20	2 66	13	.85	0	0	March.
April	63 6	73.3	50.4	10.3	18.9	75.8	53.2	6	4	6	10	5	3	2	12	2	13	7	10.8	23.5	N. - 6	5.93	16	1 52	2	1	April.
May	67.0	80.2	55.6	9.8	19.0	81.0	58.5	.5	6	6	14	4	6	0	12	0	3	17	7.9	16.4	N -10	4 16	19	1 16	1	0	May.
June	75.5	84.0	66.2	10.6	14.8	86.6	67.9	.5	0	0	5	1	5	6	15	3	8	17	6 0	12.3	S.W. 21	4.91	15	2.15	0	0	June
July	73.5	87.4	69.4	11.0	14.8	82.4	68.4	.4	1	0	0	2	5	3	20	3	5	24	5.8	13.5	S.W. 12	5 58	13	2 68	2	0	July
August	79.8	90.4	66.6	10.5	16.2	82.2	67.2	.5	2	1	7	1	1	1	17	4	7	23	5 8	18 8	S.W. 7	5 64	15	1 14	4	0	August.
September	76.6	85.0	67.2	10.5	13.6	82.9	59.1	.7	3	0	5	3	8	6	17	2	4	15	7 6	29.3	S W. 13	8.02	14	2 60	2	2	September
October	73.8	83.2	65.4	7.2	11.6	78.8	58.9	.6	1	0	26	5	18	2	5	0	0	6	10 1	21.3	N.E. -22	1 98	10	.66	0	0	October.
November	67.6	80.0	56.6	8.2	15.6	74 7	53 4	.6	4	7	13	1	3	3	6	5	2	20	7 8	14.9	N E -24	5 17	20	1.36	2	0	November
December	63.6	73.2	47.8	8.2	17 6	74.7	57 2	.7	0	4	16	7	1	0	7	6	6	15	10 4	28 6	N.E. -22	4.67	19	1 49	1	2	December.

Mean atmospheric pressure for the year ..... 30 115 inches.
Mean temperature of the air for the year ..... 69 9 degrees.
Mean relative humidity for the year .... 79 3 per cent
Mean hourly velocity of wind for the year.... 8.5 miles.

Total amount of rainfall for the year ... ... 57 91 inches.
Difference of rainfall from the average of the past nine years .... 3.27 inches less.
Rain fell on 191 days during the year

METEOROLOGICAL OBSERVATIONS, BERMUDA. 1900.

Observatory, Prospect Hill, Latitude 32° 17' 40" North; Longitude 64° 47' 00" West. Elevation 151 feet above sea level.

Observations taken daily at 8.41 A. M. and 8.41 P. M., by S. TAYLOR, Lance-Sergeant, Royal Army Medical Corps.

Month.	Temperature of the air.			Daily Range.		Relative Humidity.				Wind. Number of observations from:									Velocity of wind.			Precipitation.					Month.
	Mean.	Highest.	Lowest.	Mean.	Greatest.	Mean.	Lowest.	Mean cloudiness.	Days completely clouded.	North.	Northeast.	East.	Southeast.	South.	Southwest.	West.	Northwest.	Calm	Mean miles per hour.	Highest days velocity per hour.	Direction and date.	Amount.	No. of days on which rain fell.	Highest amount in any day.	Thunderstorms.	No. of gales.	
January	62.8	73.4	53.0	8.6	16.8	78.5	49.8	.7	5	3	10	4	3	2	14	3	4	19	8.4	15.5	W. -21	5.60	22	1.90	1	0	January.
February	62.1	73.4	49.6	7.2	12.0	76.5	56.0	.8	5	4	8	0	3	0	13	3	17	8	11.2	18.0	S.W. 22	5.35	16	1.12	1	4	February.
March	62.5	71.8	48.6	10.0	17.2	78.7	57.0	.7	5	7	3	0	3	2	14	10	8	15	11.7	26.8	N.W. 13	8.08	19	1.96	3	4	March.
April	64.4	75.4	49.6	9.7	21.8	75.4	57.0	.5	0	3	9	1	2	4	13	13	10	5	10.0	25.8	N.W. 6	1.59	13	.42	1	1	April.
May	69.0	78.4	56.8	10.0	15.8	83.1	56.5	.6	8	1	11	0	5	4	24	3	4	10	8.5	21.1	N.E. 11	7.47	11	1.60	2	0	May.
June	74.1	83.0	61.8	10.0	15.8	86.2	61.1	.6	4	1	1	5	15	2	25	1	3	7	8.0	19.5	S.W. 19	5.25	12	2.16	1	0	June.
July	79.3	91.2	67.2	12.5	17.6	78.8	58.9	.5	0	1	4	1	8	1	27	4	6	10	5.8	9.6	S.W. 7	2.38	9	1.36	5	0	July.
August	79.4	89.8	68.8	10.9	14.6	80.4	55.6	.6	0	2	3	2	2	0	20	5	15	13	5.5	10.5	S.W. 3	6.80	12	2.32	5	0	August.
September	76.8	88.6	59.2	10.8	21.0	76.4	55.8	.5	0	2	10	12	6	4	1	1	7	17	6.3	26.0	S.E. 17	8.30	19	2.44	3	1	September
October	73.7	82.6	64.8	8.1	18.2	78.4	54.3	.7	.5	0	6	14	12	8	7	4	1	10	8.5	23.6	S.W. 10	4.03	20	.88	2	0	October.
November	69.5	78.6	59.4	8.9	12.4	79.2	50.8	.6	0	1	7	5	8	6	10	2	3	18	7.1	15.0	S.W. 27	3.97	21	.90	1	0	November.
December	64.8	75.8	53.6	8.3	17.4	77.1	50.1	.7	5	11	6	0	4	3	13	1	15	9	9.3	18.7	N.W. 17	8.21	23	1.90	0	1	December.

Mean atmospheric pressure for the year ...... 30.120 inches.
Mean temperature of the air for the year .... 69.9 degrees.
Mean relative humidity for the year .... 79.1 per cent.
Mean hourly velocity of wind for the year ... 8.4 miles.

Total amount of rainfall for the year........ 67.03 inches.
Difference of rainfall from average of the past nine years............ 5.74 inches more.
Rain fell on 197 days during the year

e.—Drouths and Famines.

Throughout the early history of the islands there were frequent seasons of scarcity of food, and sometimes of genuine famine during the winter, but the reasons for this are frequently not given, except as an infliction sent upon them by the Lord for their sins, as stated in the proclamations of the governors.

The causes of some of these famines have been mentioned in other chapters. Not infrequently lack of food was due to the destruction of the crops by hurricanes, as in 1629, when the "great guste" of August 16 destroyed all their crops and many of their houses and forts, and was followed in the next winter by a partial famine. (See p. 497.)

In 1616 to 1619 great scarcity of food was due to the plague of wood-rats that ate up all their crops, even digging up the seed as soon as planted. (See Part III, ch. 33.) But several seasons of great scarcity have certainly been due to summer drouths, though these are not often very severe.

A proclamation for thanksgiving was issued by Governor Sayle, Thursday, Aug. 22, 1662, because it had pleased God "to send us a gratious rain in a plentiful manner, thorow his tender mercies and compassions." He explained that before the rain came, he had been about to appoint a day of fasting and prayer, on account of "a great and terrible drouth upon the land, that all things were even withered and dried upp, soe that the dumb creatures began to languish."

In the summer of 1784 there was a severe drouth. It was so severe that according to an item in the Royal Gazette, "there is scarcely any grain left for the horses and cattle."

f.—Temperature of the Sea.

The average surface temperature of the sea varies in different months, about as follows:

January	59°–68° F.	July	79°–83° F.
February	59 – 68	August	82 – 85
March	62 – 66	September	83 – 75
April	66 – 71	October	75 – 69
May	70 – 76	November	69 – 65
June	75 – 80	December	65 – 61

19.—*Remarkable Instance of the Death of Fishes, etc., due to Coldness of the Sea, in 1901.*

During the months of February and the first part of March, in 1901, the weather at Bermuda was unusually cold, stormy, and wet. The temperature fell, at one time, as low as 45 F. The continued

low temperature and the cold northwest winds, persisting for many days together, appear to have been sufficient to cool the sea-water beyond the limit of endurance for many of the tropical fishes found there, so that vast numbers died and were washed ashore, especially during the first week of March, all along the coast, but more abundantly around the shores of Hamilton Harbor and the adjacent islands. The stench from their decomposition became so great that the local government was obliged to aid in their removal, early in March, for sanitary reasons.

The fishes that died in the largest quantities were two of the common shallow water species, viz: the hamlet grouper and the red squirrel fish. Later in the season these and other fishes that had previously been common were found to be scarce and difficult to obtain. In fact, most of the ordinary market fishes were much scarcer than ever before.

Among other interesting fishes seen dead on the shore were the green parrot-fish, large porcupine-fishes, hog fish, Spanish lady-fish, trunk-fish, angel-fish, etc.

The following partial list* of species includes those that were particularly noticed among the dead fishes, March 8th to 10th :—

Squirrel-fish	*Holocentrus Ascensionis*
Hamlet Grouper	*Epinephelus striatus.*
Parrot-fish	*Pseudoscarus guacamaia.*
Porcupine-fish	*Diodon hystrix.*
Trunk-fish	*Lactophrys triqueter.*
Cow-fish	*Lactophrys tricornis.*
Small Rock-fishes	*Mycteroperca bonaci* (young)
Spanish Angel-fish, Catalineta	*Holacanthus tricolor.*
Rainbow Flounder	*Platophrys lunatus.*
Guapena; Ribbon-fish	*Eques lanceolatus.*
Green Moray	*Lycodontis funebris.*
Bermuda Hog-fish	*Lachnolaimus maximus.*
Spanish Lady-fish	*Harpe rufa*

In this list, very incomplete as it must be, there are two species that had not been previously recorded from Bermuda waters, so

* I am indebted to my son, A. Hyatt Verrill, for part of the above list, for he arrived in Bermuda March 7th, when the shores were still covered with the dead fishes, though most of them were then so badly decomposed that they could not be preserved. Had he been on the ground a week earlier, he could have made, without doubt, a very valuable collection of the fishes, including many rare species not in the above list. When I arrived at Bermuda, April 12th, the most of the dead fishes had disappeared, though skeletons of some of the more abundant species were common; but a few dead, or nearly dead, specimens of some species were still often found floating at the surface.

far as I know, viz: the Guapena (*Eques lanceolatus*), of which a single specimen, with its characteristic color markings still visible, was found dead on the shore near Hamilton; and the Green Parrot-fish (*Pseudoscarus guacamaia*), which was found in considerable numbers on the shore of Long Bird Island. The latter was recognizable on account of its remarkable turquoise-blue teeth, some of which were preserved by Mr. A. H. Verrill.

Those fishes that habitually live in deep water, among the outer reefs, such as the red snapper (*Neomœnius ayu*), large rock-fishes (*Mycteroperca bonaci*), amber-fishes, etc., appeared not to have been much affected.

Many of the corals seemed to have been injured also, and some were killed. In Harrington Sound and Castle Harbor we noticed many recently dead specimens of Porites (*P. clavaria* and *P. astreoides*); some of *Oculina;* and the "rose-coral" (*Mussa*, or *Isophyllia, dipsacea*), and in Harrington Sound, large numbers of dead specimens of the "hat-coral" or "shade-coral" (*Agaricia fragilis*).

It was also remarkable that the very common "rose-coral" (*Mussa*, or *Isophyllia, dipsacea*), even when apparently healthy, was very rarely seen expanded, in March and April, 1901. Indeed, I do not think that a single specimen, of the hundreds that were examined during the month of April, was in full expansion. Nor could we induce any of the numerous specimens, brought in for the purpose of study, to expand satisfactorily, although they were treated with the greatest care. This was in very marked contrast with its behavior in the spring of 1898, when nearly all the specimens were found fully expanded and active, and when brought into the laboratory, with no particular care, they would expand fully and freely, for days together, presenting a very beautiful effect, owing to their various bright colors, among which emerald-green tints were conspicuous. Last year the brighter tints were mostly lacking, and gray and lavender were the predominating colors, probably on account of their less healthy condition.

One very large specimen of the Octopus (*Octopus rugosus*) was found dead on the shore, early in March. This species, also, like many others, seemed to be far less common than in 1898. But as a rule, there did not seem to have been any noticeable change in the numbers of most of the Mollusca, Crustacea, annelids, and other invertebrates that live buried in the sand or sheltered in cavities of the reefs. Some of the crabs that live exposed on the shores appeared to have been killed in large numbers. The very common

Cliff-crab (*Grapsus grapsus*) was found to be much less abundant last spring than it was in 1898, and another species of Cliff-crab, having the same habits (*Plagusia depressa*), which we found common at Castle Island, Bailey's Bay Island, etc., in 1898, could not be found at all, last year, though we searched for it in the same places.

That the unusually low temperature of the water that prevailed in February and the first part of March was the principal cause of the death of the fishes and corals, hardly admits of doubt Under ordinary conditions many of the tropical species, found at Bermuda, are living in winter nearly at their extreme limit, as to low temperatures, so that even a small falling off from the usual average, for any considerable length of time, would be certain to prove fatal to them. It is certain that a marked decrease below the usual winter temperature took place during a part of February, amounting to about 2° F. below the average for the corresponding periods in most other years, as shown by the meteorological records. But the same decrease in temperature has repeatedly occurred without killing the fishes.

Unfortunately, I have not been able to secure careful observations on the temperature of the water, during February and March, 1901, but any marked decrease in the average temperature of the water, for a number of days, would be certain to affect the air in the same way, though to a less extent. I am indebted to Mr. H. E. Williams, Acting Chief of the United States Weather Bureau, for the following statement of the temperature and rainfall prevailing at Bermuda, during February, 1901:

"The mean temperature at Hamilton, Bermuda, for February, 1901, was 59.5 F. The average temperature for February at Hamilton is 61.5. The rainfall for the same month was 5.56, being 1.16 inch in excess of the normal. For March, 1901, the monthly mean temperature was 62.4 F., or 0.2 above the normal. The rainfall was 8.55 inches, or 2.90 inches above the normal. The month of February was an exceedingly stormy one over almost the entire North Atlantic, there being a succession of gales from the beginning of the month to about the 26th. Many of these disturbances extended as far southward as Bermuda. The weather for March was decidedly more tranquil, although a greater amount of rain fell."

That the mean temperature of the air was not sufficiently low, during February and the first week of March, to have directly caused the death of the fishes, is evident, because it has often been at least two degrees lower during January and February, in other years, without producing any such effects.

The most marked and remarkable feature in the meteorology of February was the unusual persistence of the northwest winds. According to the meteorological tables kindly furnished to me by Mr. T. G. Gosling, of Hamilton, northwest winds are recorded forty-two times in February, 1901, as contrasted with nineteen times in 1900. They were continuous for four days, from the 5th to the 9th, and again six days, from the 13th to the 19th. North and northeast winds were also frequent. These northerly winds were usually accompanied by a fall of six to nine degrees in the temperature of the air, as contrasted with southerly and southwesterly winds. That these persistent northerly winds caused currents of cold northern waters to impinge upon the shores of the Bermudas can scarcely be doubted. Moreover they might easily have caused an upward flow of the cold waters that rest against the submerged slopes of the islands at the depths of forty-five to sixty fathoms and more, for the surface currents, set in motion by the long-continued northerly winds, would inevitably also cause an upward flow of the colder waters of the submerged slopes, as I have many years ago proved to be the case on our own coast. By these combined effects, it is easy to understand how the body of shallow warm waters around the Bermudas could quickly have been cooled sufficiently to kill the more sensitive species of tropical fishes. These would naturally be those that habitually live in shallow water and among the sheltered places near the shores, where the water is usually warmest.

I was told by elderly and intelligent persons, who have always lived in Bermuda, that no such instance of the death of fishes in large numbers had occurred there within fifty to sixty years, or so far back as they could recollect. Nor can I find any record of any similar event in the early annals of Bermuda.

Several instances of the death of vast numbers of fishes on the Gulf Coast of the southern United States, and especially on the west coast of Florida, are on record. The actual causes of the fatalities in that region are not fully known. In view of the instance recorded above, and the famous case of the death of the tile-fishes, etc., beneath the inner edge of the Gulf Stream, in 1882, it is not improbable that the Florida cases were also due to periods of unusually low temperature, acting upon tropical fishes that were living at or near their extreme northern ranges. Thus a slight fall in the temperature of the water, below their critical point, might have been sufficient to kill them, as in the case at Bermuda and in that of the tile-fish.

Comparative Tables of Daily Observations for February and March, 1900 and 1901.

I am indebted to the kindness of Mr. T. G. Gosling, of Hamilton, for the following tables, which throw considerable light on the condition of the temperature and winds just before and at the time of the mortality of the fishes in 1901, as compared with similar tables in 1900. It will be seen that the averages are decidedly lower in 1901. But evidently the most significant point is the great predominance of Northwest winds in 1901, for there are 42 cases, as against 19 in 1900. Such winds not only cause a fall of temperature in the air, but they bring in currents of cold water from the northward, and from deep water, if long continued, as they were in February, 1901.

The observations were made at 10 A.M.; 12 M.; and 3 P.M.

	February, 1900.						February, 1901.					
Day.	Air; Temperature			Wind; Direction			Air; Temperature.			Wind; Direction		
Hours	10	12	3	10	12	3	10	12	3	10	12	3
1	67	67	67	W	W	W.	66	66	64	N.W.	N.W.	N.W.
2	66	66	66	N.W.	N.W	N W						
3	63	63	63	N.W.	N.W	N.W.						
4							62	62	62	N.W.	S.W.	S.W.
5	66	67	67	S.W.	S W	S W.	64	64	63	N.W.	N.W	N.W.
6	67	68	68	N E	E	E.	60	61	61	N.W.	N.W.	N.W.
7	67	68	68	N W	N W	N.W.	59	59	61	N.W.	N.W.	N.W.
8	65	66	65	N.	N	N.	61	62	62	N.W.	N.W.	N.W.
9	66	68	68	N	N	N.	63	63	63	N.E.	N.E.	Calm.
10	66	66	66	N.E	N.E	N.E.						
11							63	63	62	N.W.	N.W.	N.W.
12	68	70	70	N.	N.	N.	60	60	60	Calm.	W.	W.
13	68	69	69	E.	S.E.	S.E.	58	58	57	N.	N.W.	N.W
14	68	68	68	S.W	S.W.	S W.	58	58	57	N.W.	N.W.	N.W.
15	67	67	67	Calm.	Calm.	S.E.	60	61	62	N.W.	N.W.	N.W.
16	67	67	68	S.	S.	S.W.	61	63	64	N.W.	N.W.	N.W.
17	69	70	72	S.W.	S.W.	S.W.						
18							65	67	68	N.W.	N.W.	N.W.
19	65	64	63	N.W.	N.W.	N.W.	66	67	66	N.	S.	S.W.
20	62	62	61	N W	N.W.	N.W.	65	65	65	N.W.	S.W.	W.
21	62	64	64	E.	E.	S.E.	62	62	61	N.W.	N.W.	W.
22	64	64	64	S.	S.	S.	63	64	64	W.	W.	W.
23	67	67	67	W.	W.	S.W.	63	65	67	N.	N.	S.
24	66	66	67	W.	W.	W.						
25							64	64	64	N.W.	N.W.	N.W.
26	64	65	65	N.W.	N.W.	N.W.	65	63	63	S.E.	S E.	S.W.
27	66	66	63	N.W.	N.	N.	66	66	66	S.W.	S.W.	W.
28	60	60	58	N.E.	N.E.	N.E.	64	65	64	N.W.	N.W.	N.W.
Mean	65.7	66.1	66.0				62.5	63.2	63.1			

Day.	March, 1900.						March, 1901.					
	Air; Temperature.			Wind; Direction.			Air; Temperature.			Wind; Direction.		
Hours	10	12	3	10	12	3	10	12	3	10	12	3
1	61	63	64	S.E	S.E.	S.	61	62	62	N.	N.	N.
2	66	67	67	S.W.	W.	W.	63	63	63	S.E.	S.E.	S.E.
3	66	67	67	N.W.	N.W.	N.W.						
4							67	68	68	S.E.	S.E.	S.E.
5	65	66	66	N.E.	N.E.	N.E.	67	69	69	S.E	S.E.	S.
6	64	65	65	N.	N.	N.	67	68	67	S.W.	S.W.	S.W.
7	66	67	67	S.	S W.	S.W.	63	63	63	N.E.	N.	N.
8	67	68	69	W.	W.	W.	61	61	61	N.	N.	N.
9	66	67	68	S.E.	S.	S.W.	61	62	65	S.E.	S.E.	S.
10	67	67	67	S.E.	S.E.	S.E.						
11							65	67	67	S.	S.	S.W.
12	64	64	64	S.	S.W.	S.W.	66	68	69	W.	W.	N.W.
13	58	58	59	N.W.	N.W.	N.W.	65	66	68	N.W.	N.W.	W.
14	62	63	64	W.	W.	W.	65	68	68	S.W.	S W.	S.W.
15	64	67	68	S.W.	S.W.	S.W.	68	69	69	S.W.	S.W.	S.W.
16	67	68	68	S.W.	S.W.	S.W.	66	65	64	S.W.	N.W.	W.
17	68	68	68	S.W.	S.W.	S.W.						
18							62	62	62	N.W.	N.W.	N.W.
19	66	67	67	S.E.	S.E.	S.E.	63	65	65	N.W.	W.	N.W.
20	66	67	68	S.E.	S.E.	S.	65	67	68	N.E.	E.	S.E.
21	68	69	69	S W.	S.W.	W.	66	68	69	S E.	S.E.	S.E.
22	63	63	63	N.W.	N.W.	N.W.	66	66	67	S.	S.	S.W.
23	64	65	65	N.	N.	N.	64	66	67	N.W.	N.W.	N.E.
24	64	66	66	S.W.	S.W.	S.W.						
25							65	68	68	Calm.	S.W.	S.W.
26	67	68	68	S.W.	S.W.	S.W.	67	68	69	S.W.	S.W.	S.W.
27	68	68	68	N.W.	N.W.	N.W.	67	69	70	S.W.	S.W.	S.W.
28	69	69	69	S.W.	W.	S.W.	66	67	67	N.W.	N.W.	N.W.
29	65	65	64	N.	N.	N.	64	65	64	N.W.	N.W.	N.W.
30	65	66	66	S.E.	S.E.	S.E.	63	64	64	N.W.	N.W.	N.W.
31	67	69	69	S.W.	W.	W.						
Mean	65.8	66.2	66.4				64.7	65.8	65.9			

Comparative tables showing the number of times that the wind was observed in certain directions, in February and March, 1900 and 1901.

Direction of Wind; Number of Times Observed.

Month.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
February, 1900....	11	5	6	5	5	11	8	19	2
February, 1901....	5	2	..	2	2	7	8	42	2
March, 1900	9	3	.	15	4	26	12	12	..
March, 1901	8	3	1	14	6	22	4	19	1

20.—*Earthquakes.*

Very few instances of earthquake shocks are on record as noticed in Bermuda, and those few that have been recorded were slight and did no damage. One occurred June 25, 1664 (old style).

The following is from the Records of the Port Royal Parish: "upon the 25th day of June Anno 1664 being the Sabbath day, at 9 of the Clock of the forenoon, there was a great and fearfull Earthquake which did shake churches and Houses, yea and the hearts of men too."

Another is recorded Feb. 19, 1801.

In February, 1843, there was also a light shock of an earthquake, doing no damage.

21.—*Health and Diseases; Longevity; Historical Epidemics; Mosquitoes.*

Aside from the several former invasions of foreign contagious diseases and the local epidemics of typhoid fever, the Bermudas have always been unusually healthful, and the native people have been noted for their longevity. The alleged longevity of some of the inhabitants was made a special subject of inquiry by the Royal Society of London, in the questions addressed to Richard Norwood, in 1664. Perhaps the natural stamina of many of the earliest families who settled there has had much to do with the longevity.

Mr. Richard Stafford, in replying to some of these questions, wrote as follows:

"As to the Age of our Inhabitants here, some do live to an hundred years and upwards; many live till they are nigh a hundred, but few above: And when they dye, 'tis age and weakness, that is the cause, and not any disease that attends them. The general distemper that is yearly amongst us, is a Cold; and that is most gotten in the hottest weather. The Air here is very sweet and pleasant. Our Diet is but ordinary, and the People generally poor, and I observe, that poor People are most healthful." (Trans. Royal Soc., iii, p. 792, Oct., 1668.)

That the climate was very healthful for the English settlers, was recognized from the earliest times. Thus the Rev. Mr. Hughes, writing in 1615, says:

"Young children doe thrive and grow up exceeding well: the climate is so temperate and agreeable to our English constitutions."

He also mentioned, in 1621, that not one of the original 60 colonists, who went there in 1612, had died of disease, though one had been accidentally killed by the bursting of a cannon. Yet there had

been, in at least three of those years, great scarcity of food and more or less famine, when large numbers of the most worthless of the vicious people sent out in 1613 had died miserably. (See ch. 23, *d.*)

The ordinary diseases are essentially similar to those in the eastern United States.

Malaria is said to be unknown in the Bermudas, and it is not yet known whether the malaria-carrying mosquito (*Anopheles*) occurs there or not, though certain species of *Culex* are sufficiently abundant in summer.* But typhoid fever is not uncommon.

Dr. Christopher Harvey, Staff-surgeon of the Royal Navy, writing in 1890 (British Medical Journal for 1890, pt. ii, p. 1172), says that "the records of the Naval Hospital indisputably prove that remittent fever does not occur in the islands," and that of all cases of intermittent fever, not one was contracted on the islands.

In former years there have been several very severe epidemics of yellow fever, introduced from the West Indies, and first appearing among the sailors and soldiers.

It is probable, therefore, that the small mosquito that is believed to convey the yellow fever microbe is either native of the Bermudas, or else it was introduced there at each time of the epidemics, which could easily have happened. Once there, the abundant open cisterns of rain water would have afforded it ideal places for breeding and propagating the disease.

It would be of great importance to the inhabitants if they could be induced to take intelligent pains to suppress the mosquito nuisance. Much could be done by more thoroughly covering the openings of their cisterns, using wire gauze over the necessary openings; by introducing gold fishes or other small carnivorous fishes to devour the larvæ in cisterns or other bodies of water that cannot be drained off, or that are used for cattle; and by the use of kerosene or other coal oils on the surface of brackish pools, not used for cattle, where it could do no harm, but would effectually destroy the mosquito larvæ, if applied every fortnight, during the mosquito season.

Many of the small, stagnant, and brackish pools and bogs should be filled up, for some mosquitoes prefer brackish waters for breeding purposes.

In the spring months, when we were there, mosquitoes were not common, but they are said to be very troublesome in summer, which

* Mr. F. V. Theobald, in his extensive Monograph of the Culicidæ of the World, recently published by the British Museum, records no other genus of mosquitoes from Bermuda, except *Culex*. He had examined a lot of 59 specimens sent by Governor Barker, in 1897 (coll. 21, vol. ii, p. 358). He did not determine the species; probably the specimens were too poor.

could hardly be otherwise, while they have so many ideal places to breed in. The open rain-water cisterns alone are sufficient to supply millions. In case of new epidemics of yellow fever or other similar contagious diseases, it would be of paramount importance to reduce the numbers of both mosquitoes and flies to a minimum.

An epidemic of yellow fever occurred in 1819, which is, perhaps, the first one that can be identified with certainty. The disease was doubtless brought from the West Indies on a vessel.

A terrible epidemic of yellow fever prevailed in 1843. It appeared first among the troops and convicts in the barracks and prisons at Ireland Island, where the conditions were unsanitary, but just how it first arrived there, I have not seen recorded. It soon spread to Hamilton and over the islands generally, and large numbers of persons died. Governor Reid was very ill, but recovered.

One of the worst epidemics of yellow fever occurred in 1852 and 1853. Although it was most fatal among the sailors, soldiers, and convicts at St. George's and Ireland Island, it spread widely among all classes of people. Two acting governors, Phillpotts and Robe, died of it, within a week. Of the 1600 convicts then employed on the public works, 152 died of the fever.

Another severe epidemic, which occurred in 1864, was thought to have been brought in by some of the blockade-running vessels of that period.

In the early history of the islands numerous epidemics of contagious diseases are referred to very briefly, or incidentally, but usually as brought in by the vessels. We know nothing about some of these except by the references to them in the proclamations for days of fasting and prayer to cure them, which are preserved.

In those days such diseases were believed to be direct punishments inflicted on the people "by the hand of God," on account of their sins of various kinds. There is mention of but one physician on the islands for many years; Mr. Walter, a "chirurgeon," was sent out in 1616; the second, Wm. Plumsted, is mentioned in 1627.

Most of the epidemics that are mentioned, up to 1664, were probably the bubonic plague, though descriptions rarely occur. But as the vessels that brought the infection sailed from London and various European ports, where the plague then prevailed, this was the disease most likely to have been carried in them.*

* At that time "the plague" was very prevalent in Europe. In 1609, the second great London plague occurred, when 11,785 persons died in London alone; in 1620, it prevailed especially in Holland and Germany; in 1625, 35,417 died in London; it continued in England till 1664, and in other parts of Europe much longer.

Capt. John Smith and Governor Butler both state that when a small vessel, the "Garland," of 45 tons, arrived in November, 1619, after a voyage of seventeen weeks, many passengers and sailors had died, and most of those remaining were ill. Most likely this illness was bubonic plague.

Governor Butler relates that in August, 1620, the magazine ship "Joseph" arrived with a very large number of sick persons on board; many had died, and the crew were so ill and feeble that they were barely able to bring the vessel into port. Twenty to thirty of the passengers and crew had died and been thrown overboard, and others died after they were landed. No quarantine was practised in those days, and scarcely any precautions were used, though the disease was known to be infectious. Governor Butler considered it the genuine plague. He gave the following account of it:—

"Truly ther could be noe other judgement or censure passed upon this infectious disease than that it was the plaine plague, the purple marcks being plentifully discerned upon many of them. And without doubt, had it bin almost in any other place, it would have enlarged itself to a dangerous desolation; but the exceedinge excellent salubritie of the ayre surmounted all thes dangers and difficulties, and in a fewe weekes became such a conquerour as this dreadfull infection wholy ceased, and the former wonted health of the Ilands was fully recovered."

In this connection he also mentions that "in shypeing times" diseases had many times been brought into the islands and "thus recouvered."*

He relates that in consequence of his boats being employed in taking the sick ones ashore, some of the crews and others took the disease, and also mentions that many of the laborers sent out by the company were of the lowest classes, ten of the men having been taken from Newgate prison and some of the women from Bridewell, and intimates that the infection was thought to be due to this class of persons. But the wonder is that every vessel was not infected in those pestilent years, for we read of no disinfecting or fumigations.

The fact that the houses in Bermuda were, at that time, all made of palmetto leaves, and that the people lived largely in the open air, and very plainly, will account for the speedy arrest of the disease.

In Sept., 1621, the "Joseph" again arrived with many sick

* Although a pious man, there is no record that Governor Butler ever issued a proclamation for fasting and prayer against the spread of the infection. He seems to have been in advance of his time in respect to the cause and cure of infectious diseases.

persons on board, probably with the same disease. Her captain and many passengers had died. She encountered a storm close by the islands, so that it was eight days before she entered the harbor.

In this same storm a large Spanish vessel was wrecked on the western reef, but no lives were lost, though they had to abandon their ship about ten miles from land, and many of the passengers came ashore on a raft, at Mangrove Bay. This wreck and the recovering of goods and ordnance led to considerable excitement here, and subsequent investigation in London. But the officers and men testified that they were treated with great kindness by the governor.

It is recorded by Governor Butler, that the magazine ship "James" arrived at the Bermudas the last of October, 1621, also in a very sickly condition. The master had died, as well as some of the passengers* and crew. We can scarcely doubt that this infection was also the bubonic plague

* In this vessel were sent out two Indian maidens, who were sent to Bermuda in order that they might find white husbands, as was officially stated These maidens were two of the three companions who accompanied Pocahontas to England in 1616. They were daughters of Indian chiefs One had died in England, of consumption, in 1620, another died on the plague infected ship in which she sailed for Bermuda. Pocahontas herself had died in England and was buried March 21, 1617, according to the parish register at Gravesend.

Governor Butler mentions this event as follows:

"Ther wer also two Virginian virgins (one wherof died by the way at sea) shypped by the Virginia Company, and very well supplied by them, who wer by that Company recommended unto the Gouvernour, as being not only one of the Company, but a sworne counsellor in that plantation, that by his care and authoritie honest English husbands might ther be provided for them (a harder task in this place than they wer aware of), who together, after some staye in the Ilands, might be transported home to their sauvage parents in Virginia (who wer ther no lesse than petie kinges), and so be happely a meanes of their conversion."

The only remaining Indian maiden, according to Governor Butler, was well married about April, 1622, at Bermuda, as had been recommended by the Governor of the Virginia Company. "She being then married to as fitt and agreeable an husband as the place would afford, and the weddinge feast kept at the towne, in the Governour's newe house, and at his charge." The wedding was celebrated by a great feast, and in order to further increase the friendship between her people, the Indians, and the Virginia settlers, the Governor wrote letters of advice to the Governor of Virginia and "Caused the mayde herself likewise to do as much to her brother, who, by her father's late death, had succeeded in all his royalties and commande"

Governor Butler did not mention the name of the maiden, nor that of her husband. Nor does he refer to her subsequent history. This marriage took place during the visit of a vessel that came from Virginia for provisions in March, 1621, and remained five weeks.

In a proclamation for a period of fasting and prayer, to be observed every Sunday during Lent, issued by Governor John Harrison, Jan. 29, 1623, he referred to the threatened war with Spain ; to a recent famine ; and to a pestilence, then prevailing, in which both the late Governor (John Bernard) and his wife had both died and been buried in one day. Governor Bernard had died only six weeks after his arrival in the islands.

He stated that the only means of overcoming the disease was by fasting and prayer, which was the current belief at that time, and for long after, but although this treatment did not prove very effectual, it undoubtedly did much good indirectly, by allaying the fear and calming the minds of the afflicted people.

The following proclamation was issued by Governor Fflorentius Seymer (or Seymour) and refers to an epidemic of some importance. It was probably the bubonic plague, which was very prevalent in London, in 1663 and 1664.

"By the Governor, A Proclamation, May 7, 1664."

"Whereas the afflicting hand of the Almighty hath bin justly, as well as lately, stretched out against us and most of our ffamilies by sickness and distemper of bodie, which is not yet wholie abated. And I, haveing very lately received Christian premonition from our reverend Ministers, for the averting & absolute removeing (if the Lord shall soe please) thereof. By appointing and setting apart a daie of Humiliation (the sovaraigne remedy for cureing any Epidemicall sicknes & distemper). These are therefore (in discharge of my dutie, and in psuance of their desires therein) to Will and require all, and all manner of Inhabitants of these Islands, to repayre to the respective Churches whereatt the severall Ministers shall think fitt to appoint ; there to meete uppon Thursday the 12th of this instant Moneth, then and there duly and humblie to attend with them the worke of that day, more especially at the Church and in the tyme of meeting aforesaid. Whereof all manner of persons are hereby in his Maiesties name charged and Comanded to take notice and to yeald a redie observation of the day and duty as aforesaid, (intended & sett apart for the glory of our Maker, and our spirituall and temporall good,) as they will answer the contrary at their perills. And wholly to refrayne from all manner of bodilie labor and superfluous acting, speaking, or doeing that whole day."

Given under my hand the 7th of May, 1664

Fflor. Seymer."

Small pox was often epidemic in the islands, before the introduction of vaccination, and often proved very fatal.

In the Royal Gazette for Nov. 27, 1784, (founded Jan. 17, 1784) Dr. Dalzill of Somerset advertises to vaccinate "Whites and Blacks, to pay each $7.00, and find all necessaries." But this was, perhaps, vaccination with small pox virus, not with kine pox.

The regular vaccination with kine pox was certainly introduced in 1804; but a fatal epidemic of small pox occurred in 1829, when it became so alarming that Governor Popple dispatched two war vessels in quest of vaccine matter. One went to Halifax and one to the Bahamas.

In 1818 and 1819, there was a bad epidemic, said to have been of yellow fever, that spread all over the islands.

In 1779 and 1780 there was a fatal epidemic of "jail fever," (probably typhus fever) that originated among the American prisoners of war, who were crowded into the miserable, foul, and ill-ventilated prison, which was described as little better than the "black hole of Calcutta." It seems almost incredible, at this time, that English officers and governors could have been so brutal and destitute of the ordinary feelings of humanity as many of those of that comparatively modern period proved themselves to have been.* Probably that brutal "type" is not extinct, either in England or elsewhere, but only held in check by public opinion. But this pestilence spread beyond the prisons and over the islands generally, affecting the innocent and guilty alike. It may have been typhoid fever.

An epidemic of typhoid fever among the soldiers in 1868 is recorded in the British Medical Journal, p. 474, 1868.

Doctor Harvey, in the same work (1890, pt. ii, pp. 1172–3), has shown that the principal endemic fever of the Bermudas, as proved by the records of the post mortem examinations in the Naval Hospital, continued since 1811, has been typhoid fever, and that it has prevailed more or less every summer and autumn since 1811, and doubtless at least as far back as 1780. But in former times, and up to 1862, it was generally mistaken for typhus fever or remittent fever. He attributes it to the local unsanitary condition of many of the houses and out-buildings, and the use of water from polluted wells "at the grog shops and other native houses" by the sailors and soldiers, when the cisterns fail in summer.

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* English historians have found the *official reports* made at the time, regarding the condition of this prison, "too disgusting for publication."

At present, the use of drinking water from wells is prohibited, except after official inspection. But from what is now known of the modes of diffusion of this disease, it is probable that the abundant house flies convey it, in many cases, directly from infected excreta to human food and drink, for which the conditions are there generally favorable.

He considers that the epidemic of a fatal fever in 1849, which affected the natives in large numbers, but not the soldiers, was typhoid fever, the purer water supplied to the soldiers causing their immunity. But previous to that, nearly one-half the total deaths in the Naval Hospital, for a series of years, was due to this disease. In recent years, since the nature and sources of the disease have become better known, it has very much decreased.

22.—*Principal Productions and Exports, historically treated.*

a.—Ambergris, Lumber, Fish, etc.

The first article of export from the Bermudas was the large mass of ambergris found there by the three pioneers, in 1610. The amount is variously stated from 80 to 180 pounds, and its value from $14,000 to $32,000.* Governor Butler put it at nine score pounds, valued at about £5,000 sterling, which was certainly too low for that weight. He intimated that it was not all turned over to the Company, and that the captain of the ship and a Mr. Kendall, an adventurer, both of whom had been engaged with the finders in a conspiracy to retain it all, had each embezzled a portion of it.† There

* In the commission given to Governor Moore in 1612, he was instructed to pay the finder of ambergris $13^s\ 4^d$ per ounce.

Governor Butler records the recovery of 28¾ ounces in his time, for which he paid one-half the value to the finders, at the rate of £3 per troy ounce, their share amounting to £43. 6^s. 3^d. and his own to £4. 15^s, according to the rules of the Company.

In the "Orders and Constitutions," adopted in 1622, No. 124, one-fifth of any ambergris found was reserved to the Company, the rest to be divided equally between the finder and the owner of the land where found, except $3^s\ 4^d$ per ounce, which the governor was to receive.

At this time it was considered worth about £3 sterling per troy ounce, but the quality and prices varied somewhat.

According to an attestation of Edward Walker, April, 1626, 19½ ounces of ambergris belonging to Capt. Robert Folgate were sold by him for 50 pounds sterling. (See ch. 26, *c*.)

† Capt. John Smith gave its weight as four-score pounds. But probably Governor Butler was a better authority, for Christopher Carter, one of the finders of it, was living at Bermuda, in his time, and probably many others who had seen it were known to him; the interval was but seven years.

is also a hint about other frauds connected with it, in speaking of Mr. Christopher Carter, the one of the finders who confessed it. (See Part III, ch. 26, *c.*)

But although ambergris was repeatedly found there, it was never again found in large amounts. This first shipment, however, had much to do with the rapid settlement of the islands.

Cedar lumber, in various forms, was the next article shipped. An entire cargo was shipped to London in 1616, and from that time on, for more than a hundred years, much of it was constantly exported, though during most of that time its exportation was forbidden, except in the form of chests to hold tobacco, oranges, etc., unless by a special license. The chests were made very large and of thick planks, so that the lumber could be sold in London at a good price, for the cedar wood had then a high value for ornamental furniture. It cost $2^s\ 6^d$ to 3^s per foot to saw it into planks by hand in Bermuda, which must have made its price high in London. Had the Company allowed its shipment in logs or squared timber, no doubt the islands would soon have been entirely stripped. (See Part III, ch. 26, *b*, under Bermuda Cedar.)

Yellow-wood timber was also shipped, so long as it lasted, but it was probably nearly extinct as early as 1650. (See Part III, ch. 26.)

Cargoes of limestone, to burn for lime, were sometimes shipped to Virginia, in early times, and bricks were received in return.

From about 1622, Indian corn, potatoes, beef, pork, honey, wax, and salted fish (mostly groupers) were shipped in considerable quantities to the West Indies, and sometimes to the American Colonies. From 1630, oranges and lemons were also shipped to London, Virginia, and New England, more or less. But most of this trade with the other colonies was forbidden by the Company and therefore it was often done secretly.

Freedom to trade with other colonies in cattle, hogs, fruit, and other provisions was first allowed by the Company in 1644, probably in consequence of the Dutch war, and the danger of losing their own vessels. But trading in tobacco was again strictly forbidden, under all circumstances.

b.—Tobacco; Salt.

During the first seventy years of the colony, tobacco was the principal commodity exported. At first it was very profitable, but its price, which was $2^s\ 6^d$ per pound in 1620–25, soon declined to such an extent, about 1627, owing partly to the better Virginia tobacco competing with it, that it was not remunerative, and often

would not bring enough to pay the freight and duties, which were very high. Freight was sometimes as high as 2^d to 3^d per pound, about 1620–25; in 1670, it was, on the magazine ships, three farthings per pound, or if in cedar chests or casks, it was 1^d per pound, with "the weight of the chests allowed." This was seven or eight times the modern rates by sailing vessels.

The Company derived income from the freight; from a special private impost usually of 1^d to 2^d per pound; from the profit on household goods and liquors sent out; from their share of tobacco raised; from vessels seized and condemned; and from whale-oil, etc.

The tobacco was made a monopoly in 1623, and it could be imported into England only from Bermuda and Virginia, except a definite limited amount from the West Indies.

At first the King received 12^d duty per pound; about 1623 it was reduced to 9^d; still later, in 1628, to 6^d, and still less subsequently. But the Company, after 1658, imposed an additional duty, for themselves, of 1^d to 2^d per pound, in addition to their exorbitant freight charges and large levies made in Bermuda for public expenses.

The following extract from a letter sent by Mr. Perient Trott, of London, to his agent in Bermuda, on the tobacco trade, April 15, 1663, shows the condition of the trade at that time:—

"Tobacco is a miserable Cōmodity throut the world, more Burmoodas in England then will sell this two yeares. I pray take not a roll for me but what is gallant both for cutt & color, as before I writ you, and hope you have don soe, if noe such Tobacco be made take none for mee, let others doe what they will, pray follow my order."

The Bermuda Company was a sort of "Syndicate," as it would now be called, and did not allow the Bermudians to trade with any other ships, nor to send their tobacco to England on any other vessels, except their own, unless there should be an overplus. During the Dutch war, in 1642–44, they sent out no ship in two years, so that the colonists suffered great losses. These restrictions naturally led to much illicit traffic and smuggling, in spite of the severe penalties. In such operations the Bermudians soon became very expert and venturesome.

It is recorded that two vessels in November and December, 1669, took about 40,000 pounds of "contraband tobacco" to New England, and numerous other cases are recorded, as well as records of a number of vessels seized and confiscated on account of this traffic. The Bermudians often carried the tobacco far out to sea in small boats and put it aboard of vessels that had cleared.

As much as 200,000 pounds of tobacco was shipped in some of the earlier years. About 1707, its culture was entirely abandoned. In some of the last years of its culture it sold in London for only about 2[d] and 3[d] per pound, but this may, perhaps, have been owing to its damaged condition. (See Part III, ch. 28, *e*, under Tobacco.)

In 1623, it was ordered by the Council that the price of a bushel of salt made in the Somer Islands should not exceed one pound of tobacco.* At about that period salt was mentioned as being made at St. George's and other places, but probably not very largely. It is recorded as made there in 1624 and 1625. It was also made at Crawl Point and other places. But salt was also imported at the same period. Subsequently the Bermudians engaged largely in the manufacture of salt at Turks Island, in the winter, and shipping it to the other colonies. This trade was an important one in the 18th century, for they supplied Virginia, New York, and New England with a large part of their salt, down to the time of the Revolutionary War and later. During the war this traffic was still kept up secretly to a considerable extent. At that time they had no other means of obtaining necessary provision, etc., except by exchanging salt for them in these colonies.

It finally led to disputes with the Bahama government, as to the ownership of the right to make salt there without interference. Eventually the British Government gave the control of Turks Island to the Bahamas, to the great disadvantage of the Bermudians, who had built the works there and enjoyed their rights for a great many years (since 1678) unchallenged, except by foreign enemies.†

In the official reply of the Company to the government interrogations, in 1679, it was stated that no commodities were shipped to England except tobacco and some timber "than which there is nothing else growing or may be produced for shipping"; and that

* Bermuda being a small colony, far away from England, and with no trade or commerce allowed elsewhere, it was easy for the grasping persons to make "a corner" in any useful product. So that the Governors or Council often had to interfere and regulate prices of the food and wages by law, and sometimes to seize corn that was hoarded for high prices in times of famine to save the lives of those who had no food.

† They were attacked and driven away by the Spaniards in 1710. They in turn soon fitted out a privateer, in Bermuda, and drove out the Spaniards. Other quarrels with the Spanish occurred there in subsequent years. The French, from St. Domingo, captured the island in 1764 and destroyed the buildings and works, and took all the people as prisoners to Cape Francois. But the British Government soon caused the French to return the people to the island and pay damages, for there was no war at that time.

the exports to the "Neighbour-Islands are Beef, Pork, Fish, Wax, Honey, Palmetto-hats, Baskets, and Woodden ware. All about the value of six thousand pounds per annum."

They stated that there were about 400 planters; 8,000 men, women, children, and slaves; about 1,000 white persons able to bear arms. Also that about 50 blacks had been brought in and sold as slaves at about £15 per head during the previous seven years. As to commerce, they stated that about ten or twelve small vessels came to trade annually from New England, New York, Barbadoes, etc., for provisions, besides eight or ten more touch at the islands; and there were thirteen or fourteen vessels, of from 20 to 80 tons, belonging to the islands.

c.—*The Whale Fishery; Sharks Oil.*

The whale fishery was claimed as a royalty by the Bermuda Company, and the colonists were strictly prohibited from taking whales, except with special commissions, and for the Company. Under these circumstances they were not very ambitious to pursue the fishery, though several unsuccessful attempts were made as early as 1617 and 1621. The sperm whale, or "trunk whale" as it was then called, was found there, but was probably never captured in that century. At least Mr. Richard Stafford, in 1668, said that he had never known of one being killed, though he, himself, had killed many whalebone whales. In a few instances dead sperm whales had been found stranded on the reefs, and considerable oil obtained from them. One such case is recorded in June, 1676. The so-called "Right Whales" were originally very common in the spring months, breeding in shallow water about the reefs (see ch. 30). But their capture was not systematically undertaken till 1663, when special rules were enacted by the Bermuda Company, and a special stock company was organized for the whale fishery, December, 1663. This effort was not at first a success and resulted in considerable loss to the parties concerned. A writer in the Trans. Royal Society for 1665 (i, p. 11) quotes a correspondent as stating that he had helped to take two old whales and three "cubs" in 1665, and that 16 had been killed in 1666 (ii, p. 132). The largest he claimed was 88 feet long.* In November, 1667, they offered to give those of the natives

* From the description that this writer gave it is evident that this was a Hump-Back Whale, with very long flippers and a dorsal fin. Such whales are swifter and harder to kill than true Right Whales. Little account was made of the baleen, which was short, but small quantities were shipped to London Probably a few Biscay Right Whales were sometimes taken. (See ch. 30.)

who would carry on the fishery one-third of the profits. This resulted in the manufacture of considerable oil, but it also gave rise to great dissatisfaction on the part of the Company, who did not think that they received their share. At this period Norwood stated that they sometimes took two or three whales in a day.

In 1671 the whaling company was reorganized, but owing to dissensions, the taking of whales was prohibited in 1679. Complaints were frequently made of the illegal taking of whales, but probably no great numbers were ever taken in that way, in early times, for the natives lacked the means of boiling the blubber, except at the established "whale-houses"

The total amount of oil shipped in the 17th century is very uncertain, for the amount is only mentioned incidentally in recording the cargoes of certain ships. Probably the business was never very extensive, nor very profitable for the investors.

The following entries, though doubtless very incomplete, give some idea of the amount of oil shipped :

The "Elias" of London, August, 1664, carried away 44 hogsheads, or 9 tuns of whale-oil.

A ship (Hercules?), August, 1666, took away 117 hogsheads, or 29 tuns of oil.

A vessel not named, August, 1667, carried away 41½ tuns of whale-oil.

The "Elizabeth and Marie," June, 1668, took 18½ tuns of oil.

After 1700 more or less whaling was carried on, generally in a local way, down to quite recent years, the number of whales constantly decreasing. Three whale-houses formerly existed on St. David's Island; one on Smith's Island; one on Paget Island; one at Whale Bay; one at Tucker's Town.

Until 1782, licenses were issued by the Governor to those who engaged in the fishery, for which a considerable fee was paid.

In 1782, under Governor Brown, the whale fishery was made free to all.

Several vessels were built and fitted out for the foreign whale fishery about 1784, by Jennings, Tucker & Co. This business was carried on until interrupted by the war with France in 1793.

For the past thirty or forty years very few whales have been taken, though boats are kept in readiness.

Sperm Whales are occasionally seen near the islands, but are usually very shy and few are taken. A small one, about 30 feet long, was captured in April, 1901. (See Part III, ch. 30.)

Large sharks have occasionally been taken, outside the reefs, for their liver oil, from early times down to the present year. The oil was used for lamp-oil, in early times, but is now highly prized as a lubricant. The shark most commonly taken for their oil is called by the fisherman the "nurse shark," but it is probably not the true northern nurse-shark.* It may be the "Cat-shark" or "Gata," of which small specimens are not uncommon.

d.—Silk, Castor Oil, Olive Oil, etc.

In the early history of the Bermudas, many attempts were made to cultivate crops that did not prove successful, for various reasons, but perhaps oftener for the want of a market than for any other cause. Attempts were made very early to raise silk worms, and large numbers of Mulberry trees were planted for this use, about 1630, but the enterprise came to nothing. Governor Reid, about 1839, again tried to introduce silk raising, but without success. Apparently the native laborers are not equal to the constant and faithful care required for this industry. Some silk worms have been raised by individuals in recent years.

About 1630, when the price of tobacco had become so low as to be unprofitable, the Company ordered the planting of the Castor-oil plant for its oil, and sent out seed for the purpose. They were planted in 1631–34 in large quantities.

That the cultivation of the castor-oil plant was very successful is proved by the following extract from a letter of Governor Roger Wood, to the Company, in 1634:—

"Now for your oyle wee have planted and gathered so much seed as it may be lykened to Josephs provision for corne in Egypt, for wee have no place to lay it in, and now we have it wee know not what to doe with it, and before I will put a finger to a presse to make this oyle for 12d the gallon I protest I will plucke up all my trees and burne them. I like well of yor price proposed to sell a bushell as they be gathered from the Trees, the long stalkes takes off the heape of 12d the bushell, and this is so little that men can not live of lesse; but lett those oyle marchants make that good and I will deliver them 50,000 bushells of seed from the Inhabitants of these Islands yearely,

* During the time when whales were often taken, large sharks would follow the dead whales that were towed ashore, being attracted by the blood, and sometimes they damaged the whales considerably. As an offset, the fishermen used to take the denuded carcasses of the whales outside the reefs and use them for baiting the sharks, spearing those that came around the bait.

for now they will not give a groat a bushell for them, and I believe their mills will stand still if they continue so, yet Mr. Jenour hath bought 1500 bushells for Mr. Gowes cheap enough for such ones, and [he] is my best chapman, who offers me 2s 6d a bushell for cleare seed and 8d a bushell for seed excellently cleared to the white husk; but I heard yesterday Mr. Painter sayth such seed will be worth 12d per bushell by his experiment, who made 22 gallons of oyle in one day, and I think will be able to send home a pipe or a butt or 2 hogsheads to get the tother £40 of the Compa. w'ch he makes account to have, but he is behoulden to your querne to cleane his seeds, for William will not meddle with that busynesse."

It does not appear from the records that this crop was ever of commercial importance there.

The culture of Olives for the oil was many times tried in a small way, and Richard Norwood produced some oil in 1660, and sent it to the Company in London. But the business never succeeded, though large numbers of trees were ordered to be set out. Perhaps the Olive could now be profitably raised for pickling, as in California, if choice varieties should be planted, but it is doubtful if it would make so large returns per acre as the onions.

e.—Sugar, Cassava or Tapioca, Wheat, etc.

Sugar canes were planted by Somers in 1609, but they were eaten up by the wild hogs. More were planted by Governor Tucker, in 1616. After that time various efforts were made to raise canes for sugar, but it never grew very well, having "uncommonly short joints." In spite of the unfavorable results of all the early attempts, the Company in 1620 ordered a quantity of canes to be planted on every share of land, and instructed the Governor to see to it that this should be done, which he did, so far as he was able, for suitable places were found to be far from common. But this attempt had no success. Finally, when a small quantity of sugar began to be made, about 1670-75, the Company forbade the use of cedar wood for fuel to boil the juice, and so its manufacture was abandoned. It is probable that enough sugar for domestic use was never made.

It is recorded that Capt. John Hubbard made a box of sugar in 1670 and sent it as a present to the Company, for which they returned their thanks and made him a present of an "Anker of Brandy." But they adhered to their prohibition of the use of cedar for fuel, and passed a more stringent law to the same effect, but with

larger fines, in 1675. The sugar cane is now only occasionally seen in gardens.

The cultivation of the Cassava was undertaken about 1619, or earlier, and high hopes were at first entertained of its great usefulness and profit. Probably the preparation of the cassava required too much trouble and care for the rather indolent natives, for it never became an important crop. It is still cultivated, to some extent, for domestic use on festive occasions, as in making cassava puddings, especially at Christmas time.

Cassava roots were among the things sent to Virginia by Governor Butler, in 1621, but probably they were intended for planting.

The Taro or Eddoe (*Colocasia esculenta*), the "Tous-les-mois" (*Canna edulis*), and the true Yam (*Dioscorea lutea*) were probably introduced at an early period from the West Indies, perhaps even in 1616. They have been long cultivated locally, for domestic use; but none of them have been raised in commercial quantities, though the Tous-les-mois is sometimes sold in the market at St. George's. Probably either could be largely raised, were the demand sufficient.

In 1670, the Company urged the improved culture of "English wheat," but there is no record of its success at any period.*

Attempts had been made in the earlier periods to produce saffron, indigo, madder, grapes, aloes, anise and coriander seeds, and many other minor products, but without any commercial success. (See Part III, chapter 27, for more details.)

Sweet potatoes were probably introduced in 1616 and have always been cultivated, to a considerable extent, for domestic use. The amount in 1844 was recorded as 11,269 bushels. There are no records of any considerable amounts having been exported, though probably they may have been quite largely shipped to New England and New York by the local trading vessels, with contraband tobacco, etc., in former times. The amount now raised is about 500,000 pounds annually.

f.—Bananas, Pineapples, Oranges, Lemons, etc.

Bananas were introduced in 1616 and soon became very abundant. They have formed an important article of food ever since that time, but are now only raised for local consumption, for they cannot compete with those from the West Indies and Central America in the

* Governor Butler, when enumerating the productions, in 1619, said: "Store of corne (I mean Indian corne, for the Christian proves not as yet to be had, by overunkindnesse of the ground runnes all to grasse)."

American markets. In early times they were preserved in different ways and shipped to London to some extent. The present production is from 10,000 to 12,000 bunches. (See ch. 27.)

The Pineapple was also introduced in 1616 and flourished very well for some sixty years. Large quantities were raised, about 1630 to 1670, and many were shipped to England. But probably the long voyage was not favorable for this trade, at that time. At present they are seldom cultivated.

Oranges and Lemons were also introduced before 1617, and flourished luxuriantly. They were soon widely cultivated and produced excellent fruit, much of which was exported to London, Virginia, New York, and New England. For a long period, after tobacco ceased to be profitable, oranges formed one of the principal exports to London, and they were sometimes shipped even to Barbadoes. It is recorded that in 1660 a vessel sailed for Barbadoes "filled up with oranges and potatoes."

There are records of shipments to New England as early as 1636, but especially after 1644, and this trade continued for a long period. Oranges were often shipped in large quantities to London, from 1644 to 1700 and later. The London Company, in 1677, sent a vessel to Bermuda with special orders to take back 400 chests of oranges, and many vessels returning from the West Indies to England used to call there to complete their cargoes with oranges. At some periods (1632, 1671), this trade was nearly destroyed by the Company prohibiting the use of cedar lumber for chests in which to ship the oranges. As they had no other material suitable for orange chests, this was nearly equivalent to suppressing the trade altogether, except as it may have been secretly carried on with the colonies. At such times, and later, onions and oranges were sometimes shipped in baskets made of palmetto leaves.

Sometimes, as in 1659 and 1673, this oppressive law was so modified as to allow oranges and other native products, except tobacco, to be shipped in cedar chests. But their cultivation greatly declined from 1770 to 1840.

The Bermuda oranges were very highly esteemed, though there is no evidence that any particular trouble was taken to secure choice varieties by grafting, until modern times, as is now universally done in Florida and California.

Most of the orange and lemon trees were killed or ruined (about 1855–70) by a disease or blight, which seems to have been caused mainly or entirely by scale-insects, which were neglected and allowed to increase to infinite numbers.

At the present time a few good oranges are raised, on some large estates, for family use, and some are sold for local consumption, but not enough to supply more than a small fraction of the local demand Most of the trees that I examined were more or less infested with scale insects, but usually were not badly damaged. (See ch. 27.)

The number of oranges produced in 1881 was 24,228 dozen; in 1891, 12,871 dozen; in 1901, 109 dozen. Of lemons, in 1881, 2,580 dozen; 1891, 1,125 dozen; 1901, 264 dozen.

Peaches were at one time, especially about fifty to sixty years ago, raised in large quantities, but owing to the ravages of insects, allowed to go on unchecked, and perhaps of fungous diseases also, the trees have nearly all been killed.

g.—Corn or Maize.

Indian corn was raised by the three pioneers in 1610-12, and from that time forward it formed, with potatoes, the staple food product of the islands. From 1615 down to 1684, or later, stores of Indian corn were constantly kept in the magazines at the principal forts and elsewhere, for a reserve against scarcity. As much as 300,000 ears were sometimes stored for this purpose, and renewed annually.*

It was stated by Governor Butler that Deputy-governor Kendall, in 1616, sold to a pirate vessel 300,000 ears from the King's Castle, for his own benefit (and the promise of a share in subsequent plunder, which he did not get). Levies for public purposes were often made in corn, counting the ears, but finally it was found that dishonest persons cheated by retaining the larger ears and sending away the small or damaged ones, to pay their debts, and so a law was passed in 1623, requiring corn to be reckoned by weight.

* The early writers give little information as to the modes of preparation and cooking of the corn. Probably the corn meal was, for a long time, prepared entirely by pounding it in a mortar. In one case the governor complained to the Company that instead of keeping their muskets in good order, the men had converted them into pestles for pounding corn

In connection with the records of the interminable and bitter religious dissensions and persecutions, about 1640 to 1660, a famous "Mill" in Pembroke Parish is incidentally mentioned as a place where the dissenters from the established church were wont to meet, for services. This was probably a grist-mill for grinding corn by a windmill. There is a place on Spanish Point still called "The Mill," perhaps the site of the ancient mill, which was thus occupied as an illegal church in 1647 and 1648. The clergyman, Rev. Nathaniel White, was imprisoned in 1648 for "continuing the gathering of people at the mill, contrary to the laws and orders." He was afterwards banished (in 1649) to Eleutheria, but later, was allowed to return.

In early times the corn was often badly damaged by "weevils," causing great loss.* It was early accidentally discovered that if it were kept with the husks on the ears it was much less liable to be damaged in that way. During the 17th century large amounts of corn were exported to the West Indies, but no definite figures are usually given. It was also sold to vessels touching at the Bermudas for supplies. The amount raised in 1900 was 1,301 bushels.

h.—Potatoes, Onions, Tomatoes.

Potatoes were first raised here in 1613, and soon became very abundant. They were early shipped to the West Indies, Virginia, and New England. In 1620, 20,000 bushels were shipped to Virginia. A large supply was sent to New England in 1636, in a time of scarcity there.† They have always formed a staple article of food in Bermuda, and also one of the most important exports. In modern times the quantity annually shipped to New York has been large, as compared with the amount of land in cultivation. (See table.)

According to Governor Lefroy the amount shipped in 1876 was 33,099 barrels or 2,260 tons. General Hastings stated that in 1890–91, 80,000 bushels were shipped, on which the duty was $20,000.

The largest crop that I have seen recorded was in 1882, viz: 40,503 barrels, valued at £76,560. The smallest crop in 20 years was 13,390 barrels, in 1885, valued at £15,091. During this period the crop has generally been between 20,000 and 30,000 barrels.

The seed potatoes are all imported into Bermuda from the northern United States and the British Provinces. Various early varieties are cultivated, but to be saleable in New York they must be more or less red, like the Early Rose, Garnet, Prolific, etc., otherwise they would not be thought genuine by many.‡ They are planted from Oct. 15 to Feb. 15, and mature in 80 to 90 days.

* Probably *Silophilus granarius*, the grain and corn weevil of Europe and America. (See ch. 37.)

† January 8, 1636, the following arrival is recorded: "The Rebecca arrived in Massachusetts Bay from Bermuda, with thirty thousand weight of potatoes and stores of oranges and limes which are a great relief to our people—but their corn was sold to the West Indies three months before. Potatoes were bought there for two shillings and eight pence the bushell, and sold here for two pence the pound."

‡ It seems to be popularly believed, in our cities, that the Bermuda potatoes belong to a red variety peculiar to those islands, and some imagine that the color is due to the redness of the soil there.

Potato plants, in Bermuda, do not grow just as in the United States, for they form much shorter and less branched roots. Each plant usually produces only

At the present time, and for some years past, the early onions and potatoes have been the principal crops exported. They are now shipped almost entirely to New York, and are always in demand, at a good price, though the import duty is unreasonably high.

Owing to the limited amount of fertile land, and its high price, and the expense of labor, intensive farming is the only method that can be profitably employed. The crops must either be such as can be produced in large quantities per acre,* and in two or more crops each year, like the onions and potatoes, or else one that will bring a high price, like the Easter Lily bulbs.

The cultivation of onions on a large scale began about 1830; but considerable quantities had been shipped to the West Indies even during the 17th century. In 1832, the crop was 253,000 pounds; in 1835 it was 478,800 pounds; in 1844, 332,735 pounds. The amount shipped since 1870 has varied considerably.

Previous to 1875 it was usually less than 150,000 boxes. Since 1880 it has usually varied from 200,000 to 350,000; but in 1899 the amount was 462,701 boxes, valued at £66,252, the largest crop that I have seen recorded. (See table.)

General Russell Hastings stated that in 1890–91, the amount paid to the United States, as import duty, on the Bermuda onions, was $104,400, at the rate of 40 cents per bushel. (Garden and Forest, iv, p. 452, 1891.) Such a duty seems outrageously high on food stuffs of such kinds. The soil and climate of Bermuda seem admirably adapted for producing the finest quality of early onions.

The variations in the size of the crop are due to several causes. Some seasons are much more favorable than others, though onions are less affected by this cause than many other crops. Sometimes the seed, which is all imported, mostly from Teneriffe and Madeira, has been scarce and not so good as usual. Two varieties are raised, red and white.

two or three good tubers, clustered close together on the short roots. Therefore they are planted in drills, and much nearer together than in New England. One barrel of seed potatoes will usually, in good enriched soil, produce from three to six barrels of new potatoes. The United States duty is 25 cents per bushel, which is an unnecessary and exorbitant tax.

* The average amount of onions produced per acre here, under the early system of culture, has been stated at 20,000 pounds. Sometimes the yield was much more in good soils, and in a favorable season. It now varies widely, according to the natural fertility of the soil and the nature and amount of fertilizers used. The use of artificial fertilizers for any of the crops is quite modern, but very desirable. Onion seed is planted in carefully prepared seedling beds, from September to November.

The onions have at times been subject to a serious fungous disease,* which causes great loss. A small insect, the "Onion Thrips" (*Thrips tabaci*) frequently causes considerable damage by biting the leaves and causing them to turn yellow. (See ch. 29 and 37.)

Tomatoes have been cultivated for a long time, and formerly were exported to New York in large quantities After 1890, the amount rapidly declined from 28,830 boxes in 1890 to 146 boxes in 1900. This was due partly to competition with the fruit raised in Florida and other southern States, and largely to the high tariff.

In 1871, the amount exported was 115,868 boxes, valued at £13,718; and in 1876, it reached 154,350 boxes, valued at £12,755, which is the largest crop recorded. Between 1880 and 1890 it varied from 122,160 boxes in 1884 to 11,283 boxes in 1889. The prices rapidly declined at the same time. (See table.)

TABLE OF EXPORTS OF PRODUCTS FROM BERMUDA, 1870–80 AND 1890–1900

	Arrowroot		Beets, &c		Onions		Potatoes		Tomatoes		Total Value of Crop
	Qnty	Value	Pkgs	Value	Boxes	Value	Bbls	Value	Boxes	Value	
	lbs	£		£		£		£		£	£
1870	7484	414			106640	19277	11790	9254	49245	5689	34884
1871	32940	1478	81	16	108400	20676	11549	10958	115868	13718	46906
1872	34445	2186	151	55	161520	31760	17948	17915	109781	12163	64085
1873	39573	1768	153	94	124780	30500	20836	19667	87507	9432	61456
1874	11608	507	367	145	156871	48012	19048	19568	80671	11528	74820
1875	39008	2398	346	195	207671	20275	31116	26403	99775	9329	58622
1876	4800	250	1043	257	163590	28457	33099	26102	154350	12755	67901
1877	21485	1084	139	162	81808	22087	21004	21005	89429	9149	53578
1878	16840	780	1332	295	178687	28090	29789	14967	118772	5688	49620
1879	21346	1317	789	165	178566	31578	31275	26785	64782	4862	64707
1880	20624	1289	1568¼	340	185581	48558	27562	20804	66975	6048	77034
1890	9213	618	5180	748	275750	82087	35714	34117	28830	2518	120075
1891	28050	1626	2514	271	304975	81446	27576	27104	11433	814	111264
1892	10000	750	1628	212	360842	55027	26878	27686	5759	262	89957
1893	35400	1709	1655	206	358027	61578	30486¼	27788	1781	187	91418
1894	19880	1002	891	111	177166	45644	20110	19482	2146	190	66429
1895	4547	227	1156	215	295269	46048	27143	27004	1021	92	73580
1896	8336	484	421	61	329477	57437	22682	19820	456	38	77840
1897	6941	429	438	49	245645	34548	20064	18527	467	28	103581
1898	22100	1212	180	17	297346	59737	21801¼	16844	226	16	79636
1899	22800	111	67	10	462701	66252	26600	24071	434	26	91470
1900	33350	1792	67	7	326697	43490	25148	22914	146	11	68214

Early beets and some other garden vegetables are now shipped to some extent to New York, but they have to compete with those grown in Florida, South Carolina, etc., with the high tariff in favor of the latter, so that this business is not a promising one, at present.

* The onion disease in Bermuda has been discussed by A. E. Shipley, in the Bulletin of the Kew Royal Gardens, October, 1887. No. 10. It causes the leaves to rot at the base.

i.—Arrow-root.

Arrow-root was introduced into Bermuda rather more than one hundred years ago, and has been cultivated for commercial purposes for more than eighty years. It is still raised in considerable quantities, but is relatively of much less importance than formerly. From 100 pounds of the root, 15 to 20 pounds of starch are obtained.*

The amount produced in 1832 was 34,883 pounds; in 1833, 44,651 pounds; in 1835, 67,575 pounds.

In 1844, the crop of rough arrow-roots was 1,110,502 pounds, yielding about 90 tons of starch for export.

During the last thirty years the amount has usually varied between 9,000 to 33,000 pounds, but in 1876 and 1895 it was less than 5,000 pounds; while in 1873 and 1875 it was over 35,000 pounds. In 1900 it was 33,350 pounds, valued at £1,792. The price has been very irregular, and the crop is very exhaustive to the soil. (See table.)

j.—Easter Lilies, etc.

The cultivation of the Easter Lily, for its bulbs, for exportation, was begun about twenty years ago, and soon attained considerable importance. Although this culture still continues, it has very much decreased within the last few years,† owing to the spread of a destructive fungous disease among the bulbs. (See Part III, ch. 27.)

The number of large bulbs suitable for exportation raised in 1890, according to the census, was 2,116,000; those for stock, 4,769,000.

The exportation of the leaves of the Cycad or "Sago Palm" (*Cycas revoluta*) to New York, for decorative purposes, was carried on to a considerable extent, a number of years ago, especially by Mr. G. W. West.

Many other vegetable productions have been exported, to some extent, at various times, for a large variety of crops can be grown here, including both those of the temperate and the tropical zones.‡

* A modern mill, with machinery for the manufacture of arrow-root, has recently been built at "Belle Vue," near Hamilton, by Mr. W. T. James. Such improvements may lead to a larger cultivation of this crop.

† It is said that the remedies now being used by many planters for the disease of the lily, and for the mite with which it is also infested, have been of great benefit, and that the yield is likely to increase. But the past winter, 1901-2, has been very unfavorable for this crop.

‡ I have been unable to find any records of attempts to cultivate certain products that have been found profitable in the West Indies, and which might, perhaps, do well in Bermuda. For instance: the cacao-tree (*Theobroma*), from

But a great many kinds of vegetables and fruits are grown here for domestic use only, the quantity often being insufficient to supply the local demand. This is, at present, the case with melons, corn, turnips, lettuce, radishes and other vegetables, as well as oranges, strawberries, bananas, grapes, pawpaws, and all the other fruits raised.

The amounts of some of these products raised in 1900 are reported as follows:—

Tomatoes	31,780 crates
Bananas	10,865 bunches
Sweet Potatoes	501,700 pounds
Turnips and Carrots	117,451 pounds
Celery, Parsley, Lettuce	18,039 boxes
Miscellaneous Vegetables	150,537 pounds
Melons	63,604
Oranges	109 dozen
Lemons	264 dozen
Other Citrus fruits	178 dozen
Grapes	1,602 pounds

Part III.—*Changes in the Flora and Fauna due to Man, with a Sketch of the Discovery and Early History.*

Modern examples of rapid changes in the flora and fauna of various countries are not lacking, but they have not been sufficiently studied. In nearly all modern instances the advent of man, and especially of civilized man, has been the prime factor in the more marked changes, either directly or indirectly.

But as aboriginal man had occupied nearly all countries, even in prehistoric times, it is usually impossible to ascertain the conditions that prevailed before human interference with nature. Therefore in most countries we can only study the influence of civilized man, as following uncivilized and prehistoric man.

Generally the early descriptions of the fauna and flora of countries when first settled by civilized men, even a few hundreds of years ago, like North and South America and the West Indies, are very imperfect and incomplete, if not misleading, for reliable descriptions seldom date from the earliest settlements. Frequently the earlier changes are the most rapid ones.

which chocolate is made. This grows in the West Indies in poor rocky soils where little else will grow, and at elevations up to 1,000 to 1,500 feet, where the climate is relatively cool. In many places it is the most profitable crop that can be raised.

The Bermuda Islands afford unusually favorable conditions, though on a small scale, for such studies, for at the time when they were first visited by Europeans, in the sixteenth century, they had never been occupied even by aboriginal man.

They were discovered a little before 1511. During the next 100 years they were seldom visited, and no good descriptions were published until 1594 and 1610. We fortunately have, for the latter period, very good accounts of the more important animal and vegetable productions, as they existed before the permanent settlement made there in 1612. We also have unusually full records of the remarkable changes that were effected during the next quarter of a century, as well as subsequently.

23.—*Sketch of the Discovery and Early History; Historical Shipwrecks.*

The early history of the Bermudas is briefly as follows:—They were discovered by Juan Bermudez, according to Oviedo. Since they are represented on the map of Peter Martyr, in 1511, his discovery must have been a little before that time. They were visited in 1515 by Oviedo, but his account indicates that bad weather prevented his landing to leave hogs there, as he intended. At least one or two early shipwrecks, of which we have no details, are recorded shortly after that time. Probably there were many other early ones of which we have no record. The islands were regarded as very dangerous to approach, even at a distance, and as the abode of demons. They were called "Devils Ilands" during that century, and were carefully avoided by all merchant vessels. It is possible that the Spanish government sent other vessels, of which we have no record, to do what Oviedo failed in doing.

Probably these islands were visited, during that period, by buccaneers and pirates, for wood and water, and perhaps for repairs. The hogs may have been secretly put on the islands by such vessels, during that century, in order to furnish a supply of fresh meat, in case of need, for it was a common custom at that time to place hogs, goats, etc., on uninhabited islands. They may have tried to introduce goats, also, on these islands, but those introduced later by the English settlers did not thrive there,* though they do at the present time. The wild hogs, however, had become very numerous in 1593.

* Probably at that time there were poisonous weeds that they ate, which may now be rare or extinct. Governor Butler suggested later that they ate too much tobacco.

a.—Shipwreck of the Bonaventura, 1593.

The first actual description of the islands was published by Mr. Henry May, in London, 1594. Mr. May was an English sailor, returning from the West Indies, on the "Bonaventura," a French privateer. This vessel, through the drunkenness and carelessness of the officers and crew, as stated by May, was wrecked on the outer reefs of the Bermudas, alongside of the North Rocks, which are detached pinnacles of limestone rock, about 12 feet high, situated about eight miles from the land. The scene of this wreck is engraved on the reverse of the ancient Bermuda seal. (See figure 29.)

This wreck occurred at about midnight, December 17th, 1593 (old style). They built a raft, which they towed behind a boat (apparently they had only one boat), and by this means, after rowing all day, 26 of the officers and men were saved, including Mr. May. He was taken on board by the captain, just as they were leaving the vessel, and when he, being an Englishman, little expected it, as he says, "leaving the better half of our company to perish by the sea."

They afterwards recovered some tools, sails, cordage, and provisions, so that they were able to build a boat of 18 tons, out of the native cedar wood. In this, at the end of five months, they sailed to the fishing fleet, on the Newfoundland Banks, and by some of those vessels were taken to Europe. May arrived in Falmouth, Aug. 7, 1593.

Mr. May published, next year, an account of his experiences, with a brief, but fairly correct description of the Bermudas and their products. He particularly mentioned the wild hogs that they found there, but which, at that time of the year, they found very lean, for lack of food. The hogs fed largely on palmetto and cedar berries, both of which ripen in the fall and early winter.

They found there a great abundance of sea-birds (Cahows and Terns) and lived largely on them and their eggs. The sea-turtles, which were large and abundant, bred there at that time and furnished them with both meat and eggs. Fish were also abundant.

The following is his description of their ship-building and furnishing :—

"Now it pleased God before our ship did split, that we saved our Carpenters tooles, els I thinke we had bene there to this day; and having recovered the aforesaid tooles, we went roundly about the cutting downe of trees, and in the end built a small barke of some eighteen tons, for the most part with tronnels and very few nailes. As for tackling we made a voyage aboord the ship before she split;

and cut down her shrouds, and so we tackled our barke, and rigged her. In stead of pitch we made lime, and mixed it with the oyl of tortoises, and as soone as the carpenters had calked, I and another, with ech of us a small sticke in our hands, did plaister the mortar into the seames, and being in April when it was warm and faire weather, we could no sooner lay it on, but it was dry, and as hard as a stone. In this moneth of April, 1594, the weather being very hot, we were afrayed our water should fayle us; and therefore made the more haste away; and at our departure we were constrayned to make two great chests and calked them, and stowed them on ech side of our mainmaste, and so put in our provision of raine water and thirteen live tortoises for our food, for our voyage which we intended to Newfoundland."

May in his narrative, states that when they went ashore in the night, they supposed they were on the shore of the island, because of the "hie cliffs," but in the morning they found that they were seven leagues away from it. He also says that after building a raft they towed this ashore "astern of their boat," and that "we rowed all the day until an hour or two before night yer we could come on land."

Historians and others have been misled by this statement and have even imagined that they must have been wrecked on some far more distant island which has since been worn away or submerged; or else that there was more land near the North Rocks. (See Lefroy, Memorials, i, p. 9.) But it is evident that May meant that it was seven leagues *as they had to row*, for they could not cross the reefs at that point, in the surf, and must have rowed along outside of the reef till they reached the present ship-channel and there entered the bay and landed, probably on St. George's Island. This would have caused them to row about seven leagues and would doubtless have taken all day with the boat heavily laden and towing a raft astern.

On the Norwood map published in 1626,* in the two lower corners

* This map was made by a very competent surveyor, Richard Norwood, who resided here many years. His first survey was made between 1615 and 1622. His completed map, dated 1622, and engraved in Amsterdam, was published and for sale in London in 1626; and this seems to be the best edition of it, for the outlines are engraved clearly and with care. Two other editions were published about the same time.

He subsequently made another map, finished in 1663, on which every lot of land was located and numbered. (See Lefroy, Memorials, ii, p. 645, reprint of map.) He died in Bermuda, Oct., 1675, aged 84 years. Some of his descendants still reside there.

are engravings of the seal of the original Bermuda Company. On the reverse side of the seal (fig. 29) there is a view of a wrecked vessel alongside of two high rocks, which are easily recognized as the two main North Rocks. The vessel, with broken masts, stands upright, between the largest rock and a small one that exists to the right, and is therefore concealed by the hull of the vessel. In a

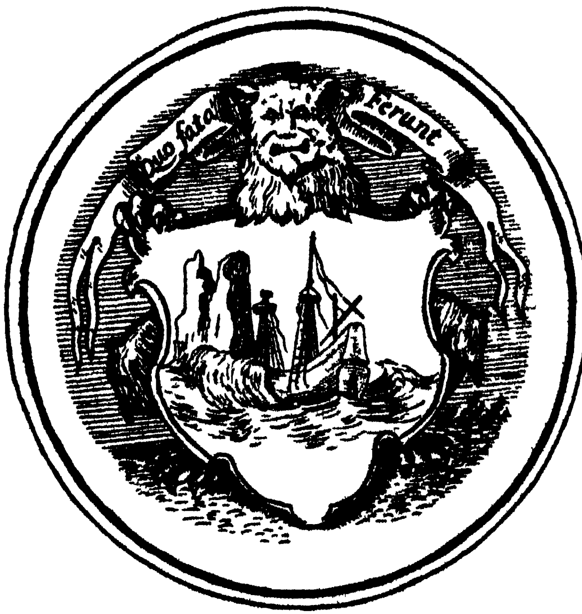

Figure 29 —Facsimile of the reverse of the ancient seal of the Bermuda Company, engraved on the border of Norwood's map of Bermuda, published in 1626. It shows the wreck of May's vessel, the "Bonaventura," in 1593, alongside of the North Rocks, which then appeared much as at present. Enlarged 1¼ times.

photographic view (fig. 30) taken in December, 1875, by Mr. Heyl, of Bermuda, a man stands where the vessel stood and the two views are apparently from nearly the same point. The two rocks in the old print are represented as nearly equal in height, but now one is decidedly lower than the other.

This ancient sketch, imperfect as it naturally is, corresponds remarkably well with the outlines of the rocks, as seen in the photograph. (Fig. 30.) This proves that these rocks have undergone but little change in general form since the early settlement of Bermuda, for this seal was probably engraved as early as 1616–18.

The drawing was very likely made by Mr. Richard Norwood for this purpose, for he was a man of good ability as a draughtsman, and was making his first survey in 1616. The scene evidently commemorates the wreck of the French vessel, the "Bonaventura," on the 17th of Nov., 1593, on board of which was the English seaman, Henry May, who published after his escape to England, in 1594, an account of his experiences.

A comparison of several photographs, taken at various times within the past thirty years, shows but little alteration in these North Rocks, but some severe storm may suddenly overthrow them. They are situated near the extreme edge of the outer reefs, about eight miles from the islands, and stand on an extensive patch of flat reef, part of which is laid bare by low tides. (Fig. 30.) They are 8 to 14½

Figure 30.—North Rocks, bearing N. 80° W.; height of highest point 14½ feet, above low-tide. From a photograph taken by Mr. J. B. Heyl, Dec. 27, 1875.

feet high and evidently are the remains of an island of considerable height and extent that has been nearly worn away to the sea-level by erosion. The evidence from the ancient seal indicates that the erosion even in this exposed situation has not been rapid, though these rocks seem to have decreased somewhat in height.

b.—Shipwreck of the Sea Venture, 1609.

But another remarkable shipwreck, which occurred there in 1609, attracted far more attention, and led to the settlement of the islands in 1612.

The "Sea Venture," a ship of 300 tons, was the flag-ship of a fleet of eight vessels, on its way to the young colony at Jamestown, Virginia, having on board Sir Thomas Gates, governor-elect of Virginia, and Sir George Somers (also written Summers and Sommers), the admiral, with about 150 others.

On July 24th (old style), when about 200 leagues from Bermuda, they encountered a terrific hurricane, which caused the ship to spring a bad leak that could not be stopped. For three days and four nights they were driven about helplessly by the storm. All the company worked day and night with three pumps and many buckets to keep the ship from sinking; 100 men working at a time.

According to Strachy* the governor and the admiral took their turns at the pumps to encourage the men. The following extracts are from his account of this storm and shipwreck:

"Windes and Seas were so mad, as fury and rage could make them; for mine owne part, I had ben in some stormes before, as well upon the coast of Barbary and Algeere, in the Levant, and once more distresful in the Adriatique gulfe, in a bottome of Candy. . . . Yet all that I had ever suffered gathered together, might not hold comparison with this; there was not a moment in which the sodaine splitting, or instant over-setting of the Shippe was not expected.

* Full descriptions of this tempest and wreck were published by Strachy, Jourdan, and others The narratives of this remarkable storm and shipwreck were published at about the time when Shakespeare was writing his "Tempest.' The coincidences in many of the details are so striking that it has been thought that he derived some of his ideas from these accounts, and that Bermuda was, in a way, the island described. During the height of the storm the bright electric discharges, called "St Elmo's Fire," appeared, gliding about on the masts, yards, and shrouds for several hours together, during the night, much as described in the "Tempest" Strachy described this appearance as follows:—

"During all this time, the heavens look'd so blacke upon us, that it was not possible the elevation of the Pole might be observed: nor a Starre by night, nor Sun beame by day was to be seene Onely upon the thursday night Sir George Summers being upon the watch, had an apparition of a little round light, like a faint Starre, trembling, and streaming along with a sparkleing blaze, halfe the height upon the Main Mast, and shooting sometimes from Shroud to Shroud, tempting to settle as it were upon any of the foure Shrouds: and for three or foure houres together, or rather more, halfe the night it kept with us, running sometimes along the Mainyard to the very end, and then returning. At which, Sir George Summers called divers about him, and showed them the same, who observed it with much wonder, and carefulnesse: but upon a sodaine, towards the morning watch, they lost the sight of it, and knew not what way it made."

Howbeit this was not all; it pleased God to bring a greater affliction yet upon us; for in the beginning of the storme we had received likewise a mighty leake. And the Ship in every joint almost, having spued out her Okam, before we were aware (a casualty more desperate then any other that a Voyage by Sea draweth with it) was growne five foote suddenly deepe with water above her ballast, and we almost drowned within, whilest we sat looking when to perish from above. This imparting no lesse terrour then danger, ranne through the whole Ship with much fright and amazement, startled and turned the bloud, and tooke downe the braves of the most hardy Marriner of them all, insomuch as he that before happily felt not the sorrow of others, now began to sorrow for himselfe, when he saw such a pond of water so suddenly broken in, and which he knew could not (without present avoiding) but instantly sinke him." . . .

"Then men might be seene to labour, I may well say, for life, and the better sort, even our Governour, and Admirall themselves, not refusing their turne, and to spell each the other, to give example to other. The common sort stripped naked, as men in Gallies, the easier both to hold out, and to shrinke from under the salt water, which continually leapt in among them, kept their eyes waking, and their thoughts and hands working, with tyred bodies, and wasted spirits, three dayes and foure nights, destitute of outward comfort, and desperate of any deliverance, testifying how mutually willing they were, yet by labour to keepe each other from drowning, albeit each one drowned whilest he laboured." . . .

"Once, so huge a Sea brake upon the poope and quarter, upon us, as it covered our Shippe from stearne to stemme, like a garment or a vast cloude, it filled her brimme full for a while within, from the hatches up to the sparre decke. This source or confluence of water was so violent as it rusht and carried the Helm-man from the Helme, and wrested the Whipstaffe out of his hand, which so flew from side to side, that when he would have ceased the same againe, it so tossed him from Star-boord to Lar-boord, as it was Gods mercy it had not split him." . . .

"Our Governour was at this time below at the Capstone, both by his speech and authoritie heartening every man unto his labour. It strooke him from the place where he sate, and groveled him, and all us about him on our faces, beating together with our breaths all thoughts from our bosomes, else, then that wee were now sinking. For my part, I thought her alreadie in the bottome of the Sea; and

I have heard him say, wading out of the floud thereof, all his ambition was but to climb above hatches to die in *Aperto cœlo*, and in the company of his old friends."

According to Jourdan, Admiral Somers showed great courage and endurance. He says that the admiral descried the land while sitting "on the Poope," "where he sate three days and three nights together, without meales, meate, and little or no sleepe, conning the ship to keep her as upright as he could, for otherwise shee must needes have instantly foundered." With all that they could do she had nine feet of water in the hold.

On the 28th of July, when they had nearly given up in despair, they made the islands of Bermuda and tried to run the ship ashore on a sandy beach that they saw, but fortunately she struck on an outlying reef, which, according to Somers' own report, in 1610, was a quarter of a mile from the shore. She lodged in an upright position between two rocks, and was so firmly wedged there that she remained in that position, so that the entire party, including some women and children, were safely taken ashore in the boats.

They landed in a "goodly bay," "upon which our governor did first leape ashore, and therefore called it, as aforesaid, Gates-his-Bay." This name, Gates' Bay, does not appear on any modern maps, nor even on the early ones of Norwood, 1622 and 1663.

Governor Butler, in his "Historye," stated that this was the bay or cove close by Fort Catherine. He was undoubtedly familiar with the details of this shipwreck. Certainly there were, in his time, some of the wrecked company living on the islands, and certain parts of the wreck were still visible. Indeed, in 1622, he recovered from the wreck two pieces of ordnance; one of these, called a "saker," was not much damaged; also a large sheet anchor, and sundry bars of iron, steel, and lead, all of which the colony much needed, as he stated in his history.

But if this cove were the Gates' Bay referred to, either the modern location of the "Sea Adventure Shoals," on the Admiralty Chart, is incorrect, or else Sir George Somers much underestimated the distance from the shore,* for the shoals so named are put on the chart at a distance of about one mile from the beach at Fort Catherine, but only half a mile from that of the nearer bay, now called Buildings Bay. If the site of the wreck be correctly located

* Wm. Strachy, in his narrative, stated that the distance was three-quarters of a mile. Silvanus Jourdan, one of the same company, stated that it was "half an English mile." The admiral's estimate would, naturally, be the more correct.

on the chart, the boats would naturally have landed in the latter bay, which was much nearer and more sheltered, for the wind was then off shore, as narrated. But probably, in the long lapse of time, without any sure marks to indicate the spot, the actual place of the shipwreck would have been forgotten.* It may well have been on one of the numerous reefs that lie much nearer to the land, off this shore. No accurate survey of these reefs was made till 1798, or 189 years after the wreck.

There are plenty of reefs that would have caught the ship, within about a quarter of a mile of the beach at Fort Catherine. Therefore it seems more probable that Governor Butler was right, as to the landing place, and that the Admiralty Chart is incorrect, as to the location of "Sea Venture Shoals." Strachy in his narrative, 1610, designated "Furbusher's Building Bay" and distinguished it from Gates' Bay. The main ship-channel now runs close by these shoals and reefs, which are well buoyed.

This shipwrecked company, according to Somers, numbered 140, but according to Strachy there were about 140 men, "besides women." The memorial tablet erected by the governor, when they departed, also stated that there were 150 persons. (See p. 543.)

As the storm abated the same day, they were able to strip the ship of almost everything that they could use, including the ordnance, cordage, and some meal, but the bread was all spoiled. Thus, later in the season, they were able to build and equip two small cedar vessels, in which they escaped to Virginia.

They remained on the islands nine months. During that time Admiral Somers surveyed and made a map of the reefs and islands. This map was never published and is unknown.

One vessel of cedar, 40 feet long and 19 feet beam, and of about 70 tons, was built under the direction of Governor Gates, on St. George's Island, by Mr. Furbusher (or Frobisher, as some spelled it), who was a master carpenter. According to tradition, it was built at the eastern end of St. George's Island, in Buildings Bay, and this is probable true. According to the statement made by Wm. Strachy, 1610, it was built in a bay opening to the northwest, so that when the violent winds blew from the "north and by west," in the winter, it made great seas and came near destroying the vessel, while on the stocks, so that they had to build around

* It must be remembered that the detailed history of those times, by Governor Butler, was not published until recently, and was previously unknown to the Bermudians and others. The same is true of other documents now available.

her a breakwater of "100 loads of stone" to protect her from the seas. As soon as launched they took her unrigged to the lee of a "little round Iland, lying west North-west, and close aboard to the backside of our Iland," for shelter, and to be handy to the pits that they had dug to collect fresh water, and also for greater convenience in sailing away. This was probably at the site of St. George's, for he speaks of this place, as distinguished from their "old quarters," on the other side of the island.

These water-pits are often mentioned by later writers. The "little round island" was probably Ordnance Island, as it is now called, which lies close to the docks of St. George's, and thus on the "backside" of their island as they were in the habit of viewing it.

There can scarcely be a doubt that the bay or cove still called Buildings Bay was the actual place where they built their larger vessel, for a memorial tablet was set up there, which was preserved for many years afterwards. It stated in Latin, that a ship of 70 tons was built at that place, by Mr. Frobisher, in 1610. Moreover, some of the shipwrecked party afterwards settled in Bermuda, so that the local traditions were continuously handed down.

This small bay or cove lies open to the north and northeast, so that a strong north or northwest wind would evidently cause large seas to enter it.

It seems strange, at first thought, that they did not build it on the harbor side of St. George's, but we must remember that at first the channels were unknown and the island was densely wooded, and they probably preferred to live on the outer coast, the better to keep a lookout for vessels. It is also stated that they kept great fires continually burning, probably as a signal to any vessel that might approach the islands.

Before sailing away Governor Gates erected a memorial tablet and cross, as seems to have been the custom in those days, to indicate a claim on the islands, for his king and country.

Strachy described it as follows:

"Our Governour set up in Sir George Summers' Garden a faire Mnemosynon in figure of a Crosse, made of some of the timber of our ruined shippe, which was scrued in with strong and great trunnels to a mightie Cedar, which grew in the middest of the said Garden, and whose top and upper branches he caused to be lopped, that the violence of the winde and weather might have the lesse power over her.

In the middest of the Crosse, our Governour fastened the Picture

of his Majestie in a piece of Silver of twelve pence, and on each side of the Crosse, hee set an Inscription graven in Copper, in the Latine and English to this purpose.

"In memory of our great Deliverance, both from a mightie storme and leake: we have set up this to the honour of God. It is the spoyle of an English ship of three hundred tunne, called the SEA VENTURE, bound with seven ships more (from which the storme divided us) to Virginia, or Nova Britania, in America. In it were two Knights, Sir Thomas Gates, Knight, Governour of the English Forces and Colonie there: and Sir George Summers, Knight, Admirall of the Seas. Her Captaine was Christopher Newport, Passengers and Mariners, shee had beside (which came all safe to Land) one hundred and fiftie. We were forced to runne her ashore (by reason of her leake) under a Point that bore South-east from the Northerne Point of the Iland, which was discovered first the eight and twentieth of July 1609."

Sir George Somers built a smaller pinnace, 29 feet long and 15½ feet beam, of about 30 tons, at a "Building Bay" on the Main Island, but the exact site is unknown.*

During this period of nine months they had there three mutinies, one murder, one execution, one marriage, and two christenings, besides other notable events.

Strachy states that Admiral Somers laid out a garden at Gates' Bay, close to the shore, and planted various vegetable seeds, which came up, but came to nothing, and that the sugar canes that he planted were eaten by the wild hogs, for he had no fences. The planting was not done at the best season, and the soil may have been poor or too dry; moreover the exposure to northerly and easterly winds and spray might have killed his plants, for they were near the shore.†

They found fishes, birds, and sea-turtles very abundant, as well as

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* Strachy's description of Somers' pinnace is as follows: "About the last of Aprill, Sir George Summers launched his Pinnasse, and brought her from his building Bay, in the Mayne Iland, into the Channell where ours did ride, and shee was by the Keele nine and twentie foot: at the Beame fifteene foot and an halfe: at the Loofe fourteene, at the Transam nine, and she was eight foot deepe, and drew sixe foot water, and hee called her the Patience."

This appears to have been the same vessel in which Somers returned to Bermuda a few months later, and in which his party returned thence to England.

† If the wood rats were then present on the islands, as seems probable, they might have destroyed the plants at night, without being observed, as in later years.

wild hogs. They made salt and salted down fishes and birds for their voyage. They also killed large numbers of wild hogs, not only for their immediate use, but they also dried the meat for future use. These provisions, together with living turtles and what meal they had left, they took to Virginia. They had fed upon palmetto berries, prickly pears, cedar berries, and the heads of the palmettoes so largely that considerable meal had been saved.

They sailed for Jamestown, May 10th, 1610, and arrived there on the 24th. They found the Virginia colony in a starving condition on account of a famine. Three persons had already died of hunger, and many were ill. Their fortunate arrival with provisions saved the colony from destruction. Soon after, finding that they had rations for only two weeks, the whole colony abandoned the settlement and started for Newfoundland for food, June 8th. Lord Delaware arriving just at this time, with three vessels and some provisions, met them on the way and they returned. The opportune arrival from Bermuda changed materially the course of history for that colony. Had they not arrived just at that time, with provisions, the colony must have been abandoned entirely, and perhaps most of the people would have died of starvation.

It is not strange that the devout men of that period attributed this remarkable series of events to the direct interposition of Divine Providence. But Admiral Somers and Governor Gates were certainly very able and efficient men, otherwise these events never could have turned out so favorably.

Scarcity of food still prevailing at Jamestown, Admiral Somers undertook to return to the Bermudas in his cedar vessel in search of more food, and probably, also, to look after the two men left there and to plant seeds for future increase. He sailed June 20, 1610, according to his own letter, but June 19th according to others. He was accompanied by another vessel, but they were delayed by fogs and storms and the latter returned to Virginia, but Somers kept on. Thus the passage was much prolonged, the admiral became ill from the hardships and exposure, and died at St. George's, Nov. 9th. His heart was buried there by his request, but his body was taken to England by his disheartened crew, who, contrary to his orders, would not return to Virginia. But they left three men behind on the islands, perhaps to keep nominal possession, and very likely in accordance with final instructions given by Somers, though that is not stated. It is related that Christopher Carter, who had previously been left there by Somers, declared that he would not desert

the islands, though all the others should, and that this induced two others to volunteer to stay behind with him.* Very likely he had promised the admiral to stay and take care of his plantation, which there is good reason for supposing he had started immediately after his arrival, perhaps early in July. We find no record of the nature of his illness, beyond the intimation that it was due to exposure, nor of what was done during the four months before he died, though Capt. Smith intimated that Somers was not idle here.

4.—*The Settlement of the Bermuda Islands in 1612.*

The Bermuda Company was soon organized in London, and the first ship, the "Plough," with Governor Richard Moore† and about 60 colonists, was sent out in May, 1612, arriving there July 11th.

On their arrival at Bermuda, Governor Moore and his company found the three men that had been left there, two years before, well and in excellent condition, though destitute of clothes. They had an acre of corn ready to harvest, and other food in abundance, and had built a cedar house and a boat. They were anxious to sail away, however, and had commenced to build a vessel. Probably they doubted if the pinnace had ever reached England; or if so, whether another would come for them. Perhaps it was partly due to the fact that they had discovered an enormous mass of ambergris, weighing about 180 pounds and worth about $32,000.00, which they naturally wished to secure for themselves, but which the governor very soon took from them. He punished one of them by imprisonment for three years for trying to conceal it. (See p. 517.)

They must have been supplied with seeds and instructions for their cultivation by Admiral Somers, before he died, for their subsequent history shows that they were men of no great ability or knowledge. It is stated that he had actually planned to start a plantation there, even if he had to do it at his own cost. Somerset was named for him, probably because he had selected it for a plantation.

The anonymous writer of 1612 (Governor Moore?) also says that they had planted "corne, great store of wheate, Beanes, Tobacco, and melones, with many other good things for the use of man," and

* The other men were Edward Chard and Edward Waters; the latter had previously been left on the islands with Carter. In 1616, he and Carter were two of the Deputy Governors, but neither proved efficient in that capacity.

† His name was often written More, but in the official commission from the London Company it is spelled Moore.

that they had also sawed and hewed timber, intending to build a vessel, in which to sail away. In another place he says that "they have made a great deale of Tobacco."

It is narrated by Governor Butler, by Capt. John Smith, and the Rev. Mr. Hughes, that when the prospective settlers arrived at the islands in 1612, they found that these men* had "an acre of good corne [wheat, according to Mr. Hughes]† ripe and ready for the gatherour; numbers of pompions [pumpkins], Indian beanes, many tortoises ready taken, good store of hogge-flesh salted and made into flitches of bacon."

Therefore the actual first planting of the islands was begun by Somers, or by these three pioneer men, in 1610. Very likely they planted many other things, not mentioned here by name.

There is a very important document, quoted above, relating to this

* One of these men, Christopher Carter, had also remained on the islands during the absence of Somers in Virginia. He was later (1616) one of the six deputy governors appointed by Moore to rule by turns of a month each, but he was an indolent ruler, too fond of his cups. Subsequently he visited London, and, as is said by some, turned over to the Company another mass of ambergris.

Governor Butler said that it was to demand his reward for finding the original mass, and that that he had begun to take "dangerous courses," perhaps to expose frauds in connection with the large mass of ambergris. However, the Company gave him a "royal lease" to Cooper's Island, by which he was entitled to all valuables or royalties that might be found there, including ambergris, which was certainly a remarkable concession, at that time.

Governor Butler said that it was in "exchange for three lives," intimating that it was to induce him not to expose the frauds of prominent members of the Company. His acceptance or choice of Cooper's Island was explained later, by his heirs, to have been because he believed he could find the Spanish treasures, supposed to be buried there, from tablets and marks found on certain trees. (See under Yellow-wood Tree, ch. 26.) He returned with the lease in 1622, and died before 1627, when the land passed into the possession of Capt. Folgate, who actually found a lump of ambergris there, in 1627, and claimed it as his own, which led to an investigation of the royal lease. (See p. 517, note.)

Governor Butler considered Carter "a great foole," and thought that he had been badly cheated in accepting Cooper's Island, but perhaps he was ignorant of the clause concerning the royalties. The island contains 77 acres, but is not very fertile.

† Perhaps Hughes considered the Indian Corn a variety of "wheat," for writing in 1614, he said:

"And now that we have found out the right seasons of the yeare to set corne, we are like, (by the blessinge of God) to have plenty of this countrey wheate, which is very good, large and faire, and more hearty and strong than our English wheate."

This remark would seem to apply to the Indian corn or maize, which was then hardly known in England. Wheat does not grow well in Bermuda.

voyage and the conditions then existing at the islands, but the name of the writer is unknown. This narrative, or rather report, concerning the islands and their productions, was written at Bermuda, in 1612, just before the return of the "Plough." The writer was, in my opinion, Governor Moore himself.

This is indicated by the business-like style of the document itself; by the statement that "Hastie occasione of business doth make mee write somewhat hastilie, etc."; by the remark that "we sent out for Hogges"; and "but our order is not to take Fish or Fowle, but for one or two meales, because that by reason of the flies, and heate of the countrey they will not keep"; and by the fact that he does not in any other way refer to any acts or orders of the governor, nor mention him by name or title, as any subordinate person would have been sure to have done.

He does not say that the governor ordered this or that, in any case. The whole character of the paper indicates that the writer was the leader and the one in authority. His lucid descriptions of the trees and their timber indicates his expert or professional knowledge of such matters, but Governor Moore had been educated as a master carpenter. It is apparently the first official report of the Governor to the Company, written rather hastily, owing to the pressure of numerous official duties, cares, and details incident to the first settlement. If my conclusion be true, it will add somewhat to the value and importance of this report, for it is one of the most detailed of the early accounts, in several respects.* I shall, therefore, hereafter speak of it as Governor Moore's Report of 1612. Governor Moore was a very conscientious and reliable man, with more education and brains than most of his colleagues, and the character of this useful report is in keeping with his personality.

Governor Butler (1619) said of Governor Moore "although he was but a Carpenter, he was an excellent Artist, a good Gunner, very witty and industrious; he built and laid the foundations of eight or nine Forts, called the Kings Castle, Charles Fort, Pembrookes Fort, Smiths Fort, Warwicks Castle, Saint Katherines Fort, &c, mounting in them all the Ordnance he had, preparing the ground to build Houses, plant Corne, and such fruits as they had." The "forts" built at that time were of cedar wood, but the rock had to be cut away in order to make level places for the gun platforms. All the labor had to be done by hand, for they had no beasts of burden, nor machinery.

* This report was printed in full by Governor Lefroy, in his Memorials of the Bermudas, i, pp. 65–72, 1877, but without suggestions as to the authorship.

So much of the time and labor of the people was required for this fortification work that the planting of corn and other crops was too much neglected, so that a famine ensued in the winter of 1614–1615, though this was probably not the only cause of it. Drought and tempests had intervened to destroy their crops in 1613. The London Company was chiefly to blame for this lack of food, for they required of Mr. Moore, above all else, that he should fortify the place at once, but they did not send out sufficient supplies of any kind. As in many other colonization schemes, there was too much ignorance, cupidity, and gross mismanagement on the part of the Company.

The "Elisabeth," with 30 colonists, arrived next, about March, 1613; the "Martha" arrived in June, 1613, with about 60 passengers. The "Elisabeth" brought 40 more passengers in September, 1613,* and also the first potato roots. Tobacco was also planted in 1613, but it had been raised in 1610 and 1611 by the men left there.

The population, in 1622, as stated by Governor Butler, was 1500, but he may not have included the women and children. In 1629, it was said by Capt. John Smith to have been between 2,000 and 3,000.

The colonists began at once to cut down and burn the forests of cedar and palmetto, not only in order to clear the land for planting, but for building fortifications, for firewood, and for other purposes. Governor Moore almost immediately began to fortify the hills and islands near St. George's, as instructed by the Company and confirmed by a special vessel, sent out only six months later to warn him of the expected war with Spain and a probable attack on the islands. This compulsion to build forts before houses, and to mount cannon before planting corn, kept the settlers from planting as much corn and other edibles as they should have done, both at this time and in later years.

Their first crop of corn was good, according to Hughes (1614),

* The sending out of these earlier vessels at such unusually short intervals was mainly due to the desire of the Company to receive the exceedingly large and valuable mass of ambergris, weighing about 180 pounds, that the three men that had been left on the islands for two years had found (see pp. 517, 546), and which, at about that time, was valued at 8 pounds sterling to the ounce.

Governor Moore discreetly divided the mass into three parts, and would only send one portion at a time. As each vessel brought additional supplies, of which they were greatly in need, this course was very beneficial to the people, although it displeased the London Company, for they cared only or chiefly for immediate gain, and wished to cause a rapid rise in the price of the stock of the Company.

though planted too late (they arrived in July). But he states that their second crop was nearly a failure. This may have been due partly to the neglect of planting at the proper time, on account of the pressing need of fortification work, and partly to the lack of care later; but the season may have been a bad one, with drouths or tempests, and the Wood Rats may have been present, even then.*

Besides, they were mostly ignorant and quite inexperienced, both as to the crops and the climate. But whatever the cause, it is evident that the Company did very wrong to send out, during the first years, so many ignorant and ill-provided poor people, taken largely from the slums of London, expecting them to clear a densely wooded country, plant crops, and build forts and houses, all in one year. The governor had on his hands more than any man could do, with the men and materials at his disposal.

It is remarkable that he succeeded by his energy and wit in keeping the colony alive. In fact, had not nature provided such an abundance of birds and fish, at that time, most of the people would surely have starved. It was by mere chance that a stray vessel, the Edwin, loaded with meal, came to the islands from the West Indies, in the middle of their second winter (about January, 1614), when they were on the verge of starvation. This was the vessel said to have introduced the wood-rats. (See Part III, ch. 33.)

The following extract is from "A Plaine and true relation of the Goodnes of God towards the Sommer Islands," London, 1621 (written in the latter part of 1620). Mr. Hughes lived in Bermuda from 1615 to 1620. After a visit to London, he returned on the "Joseph" in 1622:—

"Upon your second crop, (partly for the unthankfulnesse of some, and partly for the trial of other some) God denied his blessing, so as you received not your seede againe, therefore feare of great want came upon you Then, even then when your hearts began to be troubled with feare of want, Almighty God who never faileth nor forsaketh them that are his, did send you a comfortable supply unlooked for."†

* It is not improbable that the unsuspected ravages of wood rats were the chief causes of the failure of the crops in all these three earlier years, though they did not attract attention till 1615, when they had apparently greatly increased, perhaps largely due to their gathering, for food, in the vicinity of the cultivated land. There is no sufficient evidence that they were first introduced in 1614. (See ch. 33, *b*.)

† This is a reference to the "runaway frigate" which came loaded with meal from the West Indies, and was said to have also brought the wood-rats, January, 1614.

The wild hogs and birds were rapidly destroyed by the famished people. Another famine occurred in the third winter (1614–1615), when 150 starving people were colonized temporarily on Cooper's Island to feed on the cahow and its eggs, which they nearly exterminated that season. (See history of the Cahow, Part III, ch. 29.)

A great curse to the colony, from the first, was the large amount of liquors sent out on every vessel, for many years, by the Company, in order, apparently, to exchange it, at high prices, for the half-shares of tobacco that belonged to the cultivators. Many of the colonists were taken from the lowest classes of people in London, and drunkenness was prevalent among these and others, whenever, by any means, they could secure liquors of any kind.* Such conditions were not confined to Bermuda, nor to that particular time, but in this case the Company could have controlled it, had they chosen to do so, for a long series of years. Governor Butler and other early governors denounced the custom in the strongest terms, as did some of the clergymen, but it was continued and gave rise to vari-

* The Rev. Mr. Hughes, writing in 1620, alludes to this as follows:

"My heart giveth me, that among other sinnes, the abominable sinne of Drunkennesse, that aboundeth among you every shipping time did much favour the bringing of that judgement upon her, [the ship] to admonish some to bee no longer Bawds to Drunkennesse by sending over so much Aqua vitæ." . . . "In Summerset you know how one died suddenly with drinking himself dead drunke." . . . "Also in the Towne at St. Georges, a man of Summerset drunke himself dead drunke, and beeing by a Coroner's Inquest found guilty of his owne death, was by the commandment of Captaine Butler your Governour, buried in the highway with a stake driven through him, by them in whose company he dranke himself dead. Each of them having a paper on his backe with this superscription · '*These are the companions of him which killed himselfe with drinking.*' Two of the most notorious of them were punished, the one whipped at the Whipping Post, the other (because he was a soldier) did ride the Cannon, shot off full charged, which did shake him terribly."

"Forget not the Boats of Summerset that were over-turned with the keele upward, and some of the men drowned, because they that should guide them, were troubled in their braines with Aqua vitæ."

Governor Butler thus describes the drinking habits of the people, in 1620:—

"And, indeed, it is incredibly straunge to report what a huge quantitie of thes hott composed waters are (mis) spent yearely in these smale Ilands. Will it ever be believed (in England it selfe, which is yet too neere akinne to Germany in this; in Spaine and Italy certainely it can never) that twelve hundred persons (whereof the one halfe almost are women and children, and soe noe drinckers in this nature) should in three months space only, consume and emptye two thousand gallons of this hartburneinge geare, by powreinge it downe into their vast mawes? And yet this is the least that (truely) can be sayd of it."

ous crimes, and at times to disgraceful orgies, even on the part of the principal officers, in 1615–1616, and many misfortunes ensued.

Governor Moore, instead of receiving praise and encouragement from the Company, was criticised, blamed, and censured by them, so that he gave up his position, shortly before his term of three years expired, in 1615, and turned the government over to six deputy governors, most of whom proved worthless fellows and drunkards, though they were the "best that were there." He returned to London, deeply in debt and in disgrace, and never had much justice done him. He had to live in hiding, in an obscure street of London, for some time, to avoid arrest for debts.*

The next year (1615–1616) was a year of strange misrule, revelry, debauchery, and idleness on the part of the deputy-governors, their officers, and the people generally. It was also, at this time, that the plague of Wood Rats developed with remarkable rapidity. No tobacco of any consequence was made and little of other crops.

Governor Daniel Tucker, who was sent over in 1616, found everything in the greatest confusion and the people utterly demoralized by a year of disgraceful revelry and misrule.

It needed a man of energy and stern will to put the colony into any sort of order. Governor Tucker, though a man of not much education, with a very irascible temper, and not always with good judgment, was, perhaps, a very suitable man for the time and place. His arbitrary acts, and to us apparently arbitrary executions of criminals for minor crimes, may have been based on personal knowledge of their character and deeds that is not apparent from the records.

Some of Governor Daniel Tucker's† fortification work and trials have been described in a previous chapter (p. 447). He came with an elaborate commission from the Bermuda Company, which conferred on him far greater legal power than Governor Moore had held.

At the time of his arrival the Wood Rats had become exceedingly abundant, so that they destroyed all the crops, and they continued to increase during the next two years, in spite of all his efforts to suppress them. (See Introduced Mammals, ch. 33, *b*.)

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* Although Governor Butler intimated that there was some great fraud or secret scandal, known to Carter, in connection with the ambergris, it is evident that Governor Moore, himself, had no benefit from it, for he lived in poverty after his return to London. The Company finally gave him six shares of land for his services. But I find no evidence that he went back there to live.

† Governor Tucker returned to Bermuda and lived several years on the land conveyed to him by the Company. He died there in 1625.

One of his measures was to burn over large districts, and sometimes whole islands, thus destroying all the trees and other vegetation, as well as the rats. (See below, ch. 26, *b*.) Fortunately, in the winter of 1618–19, the rats suddenly died, all within a few days, as the Rev. Mr. Hughes stated. This averted a "general burninge" of all the Main Island, that Governor Tucker had decided to order. In the meantime the people had become much impoverished and bread had sometimes been lacking for many months at a time.

Governor Butler,* 1619 to 1622, who was an able man and also a discreet governor, tried to restrain the reckless cutting of the trees, which had even then become a great evil, and the wanton destruction of the birds and sea-turtles, but with no great success. He also greatly enlarged and improved the fortifications, and built cedar bridges between the islands, which were much needed. Even in his time, most of the land on St. George's Island had been stripped of its trees and become barren.

d.—The Fatal Famine of 1614–15; the "Feauges."

In the winter of 1614–1615 there was a peculiar fatal famine or disease, apparently due to the lack of bread-stuffs and other ordinary

* Most that is known of the history of the islands, from 1612 to 1622, is derived from his MSS "Historye of the Bermudaes" printed by the Hakluyt Society, London, 1882, edited by Governor Lefroy. The editor, when it was published, supposed that it was written by Capt John Smith, but it has since been proved that it was written by Governor Butler (see "The Academy," Dec., 24, 1893, p. 891).

The earlier part, from internal evidence, was written in 1619; the last parts, perhaps as late as 1624 or 25. Governor Butler's accounts are confirmed by those of the Rev. Mr. Hughes (1621), who lived in Bermuda at the same period.

Capt. John Smith, in his General History of Virginia, etc., 1624, made copious and often verbatim extracts from Governor Butler's Historye, without giving any credit for this information, nor in any way referring to its source.

As this was done during the life of Governor Butler, it is probable that it was with his knowledge and most likely in accordance with his wishes, for it would appear that at that time he had private reasons for not wishing to be known as the author of this work, which was left unfinished at his death.

Many of the persons that he exposed and censured were still living and in influential positions. Governor Butler, like Governor Moore, never got much praise or thanks for all his good efforts in Bermuda, but was blamed for obeying his orders and doing his duty, and falsely accused of many things that he did not do. He certainly did not enrich himself, but was much in debt on his return. Governor Lefroy states that he was subsequently made Governor of [Old] Providence, about 1638.

vegetable food, although animal food was abundant. This affected chiefly the ignorant, indolent, and vicious persons who had been sent there only a short time before by the Company.

The Rev. Mr. Hughes, who was present as an eye-witness, described it in 1620, as follows: "Your looking for more supplies out of England, and following Tobacoo to greedily, did cause you to neglect setting of corne, whereby you were brought into great want, [1615]. Then the number of people encreasing and as they encreased, sin and disorder did also encrease, which brought the correcting hand of God upon you in many wayes, so as divers did perish miserably: but consider I pray you that most of them that so dyed, were ungodly, slothfull and heartlesse men, which sheweth plainly that God hath not reserved these Ilands from the beginning of the world, to bestowe them now upon such as shall dishonor and provoke him every day as many of them did, I cannot but wonder, when I think upon the nastinesse & loathsome lazinesse, wherein too many of them died, crying night and day for meat, notwithstanding they had meat enough, if not too much, for they did nothing night and day but dresse, and eate, and so greedy, as they would not stay till their meate was sod; but more like dogges than Christians did devoure it blood rawe." * * * * * *

"They died miserably, some with meate in their mouthes crying for more. This surely was a great jugement of God upon those slothful and greedy Belly-gods and a manifest signe and token (as I said even now) that God hath not reserved these Ilands from the beginning of the world till now to bestow them upon such as shall provoke him every day, as many of them did. The correcting hand of God, which then lay heaviest upon the lazie ones, did stretch out itselfe over all, even the most industrious, when their Lines, Hooks and Nets were worne out, so as many of them also died."

It seems, therefore, that it was a case of "Natural Selection," or survival of the fittest, and probably was, on the whole, a blessing to the Colony, though other similar emigrants, quite as bad, were sent out subsequently, in 1619–20. (See p. 567.)

In regard to the cause of the death of so many of the miserable people at that time, there may be some doubt. There can be no doubt, however, that it was largely due, directly or indirectly, to the lack of suitable vegetable food, for of bread there was none.

But there seems to have been an abundance of animal food, for the cahows and their eggs were still abundant, and there were plenty of fish to be had, with little trouble, as well as shell-fish on the rocks.

Hughes and Butler, as well as Captain Smith, all speak of the gluttony and laziness of these emigrants, and affirm that large numbers died of surfeit, rather than from hunger, for the cahow was a very fat bird. Governor Moore was compelled to remove the crowd of 150 from Cooper's Island, where they were killing themselves by gormandizing the birds and eggs, to Port Royal, where they could get fish. But they were too indolent to do that, and secretly killed and ate the few cattle that had just before been sent there. He eventually had to gather them all at St. George's, and fish for them himself, to save their miserable lives, and that of others more deserving.

They seem to have been affected with some sort of a disease, which Capt. John Smith called the "Feauges." But this may have been induced by the exclusively animal diet and their gluttony. Possibly it was akin to scurvy. Hughes stated that none of the sixty original colonists died at that time. This may have been due to their having laid up some supplies of vegetable food, like dried or preserved palmetto fruits, pumpkins, etc., or they may have learned by experience to eat the Palmetto-heads and other native vegetable food, to a great extent.

That these native vegetable foods could take the place of cereals and other ordinary crops, without loss of health, was proved a little later, 1616–17, when it is stated that the colonists had no bread for about two years, on account of the ravages of the wood-rats.

Capt. Smith described the "Feauges" as follows: "He [Gov. Moore] followed the building of these Forts so earnestly, neglecting planting of Corne, till their store was neere all consumed, whereby they became so feeble and weake, some would not, others could not goe abroad to seeke releefe, but starved in their houses; and many that were abroad, through weaknesse were subject to be suddenly surprised with a disease called the Feauges, which was neither paine nor sicknesse, but as it were the highest degree of weaknesse, depriving them of power and ability from the execution of any bodily exercises, whether it were working, walking, or what else; being thus taken, if any presently gave them food, many times they straight recovered, yet some after a little rest would be able to walke, but if they found not present succour, died."

Various other details of the early history, from 1612 to 1625, have already been given in connection with descriptions of the ancient fortifications in Part I, and productions in Part II, ch. 22. Many other historical matters will be given in connection with the dis-

cussion of the Cultivation of Tobacco, and changes in the vegetation and animal life, contained in the following five chapters, and more especially in connection with Deforesting and the Extermination of the Cahow, etc. So much of the early history of the colony was directly dependent on the production of tobacco, which was the principal article of export for over seventy years, that it seems most desirable to describe the Tobacco Cultivation historically, in the next chapter. (See also p. 518.)

e.—Tobacco Cultivation, as connected with the Early History of the Islands.

It has been doubted whether the Tobacco plant was growing upon the islands before it was planted by the English, but Silas Jourdan, one of Admiral Somers' shipwrecked party, distinctly stated, in 1610, that they found there "very good tobacco." If so, it was probably introduced, like the wild olives and the hogs, by some unknown earlier visitors.

The first that was cultivated was planted in 1610, by the three men left on the islands from 1610 to 1612, for in his report of 1612, Governor Moore stated that those men had "made a great deale tobacco," among other useful products.

Planting it on a larger scale began in 1613. From that time until about 1690 it was the principal commodity exported, but its culture entirely ceased about 1707. During more than sixty years it was also used as the regular currency, in barter, and for paying the wages* and salaries, from that of the government officials down to the cheapest laborers. Fines and taxes were also paid in tobacco. The value varied, but 2ˢ and 6ᵈ was commonly the value per pound, up to about 1627.

* An act was passed by the Assembly in 1623 regulating the prices of labor. The wages of a laborer or toiler was to be no more than 1 lb. of tobacco per day; of a mason or carpenter 2 lbs.; for sawing lumber the price was to be 8 lbs. of tobacco per 100 feet. If any craftsman should refuse to work when called upon to do so, and when not already employed, or if he should leave a job before it was properly completed, he was to be put in the stocks, or else caged.

This law was reënacted in 1627. It was found necessary because these craftsmen had refused to do their work unless paid exorbitant prices, thus making a corner in the labor market of the islands. Or it might be compared to a "strike" where substitutes could not be found in trades absolutely essential to the welfare of the public.

In 1630, it was ordained that 12 lbs. of tobacco should be equal in value to 1,000 ears of corn.

Wages at the islands were paid in tobacco at the rate of 3^{d} per pound in 1670, which was probably more than its net value, after the imposts were paid in London.

The revenue from the tobacco was the main source of profit to the Bermuda Company, and they jealously guarded the monopoly of the trade in it during the entire period that they controlled the islands, or up to 1684.*

The quantity and quality varied exceedingly in different years, from a variety of causes, but the Company annually and continually complained of its bad quality. Stringent laws were in force for many years requiring careful inspection of all the tobacco by official inspectors before it was shipped, and the bad tobacco was to be immediately burned. Apparently the dampness of the climate was unfavorable for the proper curing of the tobacco, and in wet seasons much of it rotted. In some years the growing tobacco was badly damaged or destroyed by violent storms. This is recorded as occurring in August, 1629, 1651, 1668, and in other years. Probably all the autumnal hurricanes had this effect. Doubtless many of the growers were neither skillful nor careful in the art of curing, but the storms and other natural causes were important factors. On the other hand, in some seasons the crop was large and the quality good.

I have been unable to find any record of fertilizers of any kind being imported or used during all these years. Probably nothing was used except a small amount of barnyard manure, and perhaps in some cases, seaweed and dead fishes. The domestic animals were few, and the cattle do not require housing in winter, so that such manure must have been scarce and little used.

* A law making the stealing of tobacco plants a felony, punishable with death, was passed in 1623:—

"And be yt ennacted by the same, that if any p.son or p.sons shall at any tyme or tymes hereafter enter into or upon the lands or grounds of any other person or p.sons wth in the Island, aforesaid where any Tobacco or plants thereof shal be planted or growinge and shall there steale, drawe, plucke up, gather or carrye away any Tobacco or Tobacco plants against the good will or without the special lycense and consent of the owner of the same land, and be thereof lawfully convicted, that then every p.son soe offending shal be held and reputed a fellon and shall suffer death for the same, as for any other fellonious deed, Any Act, law, usage or Custom to the contrary thereof in any wise notwithstanding."

This law was so modified, in 1627, that the thief was to be fined 200 pounds of tobacco, or if an apprentice, he was to be whipped; and in addition, in either case, he was to stand at the church door, during services, with a bunch of tobacco plants hanging from his neck, on three successive Sabbath days.

Therefore, it is remarkable that any respectable crops of such an exhaustive plant as tobacco could have been raised on the same land for so long a time. It is certain, however, that the fertility of the soil had very much decreased before tobacco culture was abandoned (about 1707). But in the meantime Virginia and other American colonies had become great tobacco-growing countries (about 1626) and produced a better quality, so that the prices of the island product had fallen to such an extent that the Bermudians could not compete with any profit. In 1627 it was worth about 1s 10d in London. It was finally sold at 3d per pound in 1670. For more than a hundred years after this culture was given up, the agriculture of the islands was very much diminished, though the raising of corn, oranges, potatoes, onions, and other products for export still continued to some extent. The early agriculture was doubtless very simple and imperfect. Scarcely any implements except the grubbing hoes were in use. Plows were practically unknown until 1839, when their use was urged and introduced to some extent by Governor Reid.

In Governor Tucker's time, about 1618, 30,000 pounds of tobacco were shipped in one year. In 1620, 70,000 pounds were shipped by the "Joseph." In later years 200,000 pounds were often shipped. In 1671 one vessel is said to have carried away 250,000 pounds. In 1679 the officers of the Company stated that the annual value was about £5,000 sterling, but at that time the price per pound was very low. One year it is stated that it brought only 1½d per pound. Owing to the increasing production of tobacco in Virginia and the West Indies, and the excessive freight and duties levied upon the Bermuda product, the price rapidly fell from 2s 6d to about 9d or less per pound between 1626 and 1630. At first the duty was 1s per pound; in 1623 it was 9d; in 1628 it was 6d. The duty and freight were often more than it would bring in the London market, so that the more the colonists raised the poorer they became. Although they raised an abundance of corn, potatoes, fruit, poultry, and other food, they had no commodities with which to buy goods from England, such as clothing, so that they became very destitute of clothing and many other necessities of life, though food was plenty.*

* The destitution in clothing, etc., caused by the decrease in the price of tobacco and the high duty on it, is graphically described in letters from Governor Roger Wood, written in 1632. The following extract is from one of these:—

"To Mr. Ballene I referr the reports of his voyage, usage and affection on this very poore Island, only for lacke of Canvasse shirts and shoes and such things

At that time there were no textile materials raised there with which they could have made cloth, even if they had the skill. However, they did plant hempseed and flaxseed, in 1632 and 1633, and subsequently some cotton. But later (1644) they sent a ship to Barbadoes to trade for cotton and it brought back a cargo of 11,018 pounds of cotton, which the women and girls learned to spin.

The duty on tobacco was reduced to 6d a pound, in consequence of urgent petitions in 1627, but even then it was not remunerative under the conditions imposed by the Company. The colonists were forbidden to trade with the other American colonies, even for necessary things, nor could they trade with any ships except those sent by the Company. Yet they were compelled to do so in order to live at all, and so we find records of cargoes of potatoes, oranges, etc., sent to New England at that time. On the other hand, the Company continually complained of the poor quality of the tobacco sent to them; but those planters who occupied the public lands on half-shares complained that the Company would not pay for any part of the labor necessary to properly cure even their own share, and consequently much was spoiled for lack of sufficient help at the critical time.

The difficulties connected with the making of tobacco, especially on the plan of half-shares, are well described in the following extract from a letter sent by the Assembly, in 1627, to the Bermuda Company, in reply to a letter from the Company, dated Sept. 20th, 1626 complaining of the poor quality of the Bermuda tobacco, as contrasted with that from Virginia and St. Christopher's I., and also requiring them to return to the system of cultivation at one-half gross shares for the Company, as was customary for tenants in England:

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as will cloathe us from sunne and cold nights I thank god wee abound wth vitualls in varietye and plentie both flesh and fish, rootes and fruits, so that wee excell all the plantacons in the kings dominions, and wee desire to undertake any travell and labour if wee had a subject to worke upon to cloathe ourselves, but it is our miserie to live in these tymes that the more wee labour the more wee are undone through the extreame ympost laid upon our goods, wc'h exceeds the value of the commoditie, a thing without precedent and never before heard of. I pray God amend yt and send us help from heaven for on earth I see but little hope."

He sent a present of some tobacco to which he referred as follows, in a postscript:—

"I beseech you vouchsafe the tasting of our poore Burmoodian Tobaco wch is 2d worse than nothing the pound."

"But wee most humbly intreate you to conceive in this (as the schools distinguish the like *Similitudo non curritt quatuor Pedibus*, many things may be alike, but not alike in all things; for there is as much difference betweene a husbandman's sowing of wheate to halves in England, and planting Tobacco at halves in Somer Islands, as is betwixt black and white. The husbandman hath his hand ready for the plough, and his houses built; wee noe such thing, He hath his beasts of labor to plough his land, wee none but our hands, his wheate beeing sowen his labor and charge is little or none till harvest, ours is daylie and hourely, his crop being housed his care and charge is ended, then is our care greatest and our danger most, yea of so tickle and dangerous a nature is this Tobacco, in the house, that one houres neglect or the least want of helpe may spoyle a whole yeares cropp, neither is it in the power of man to prevent it when it is come to that passe, soe that the comparison in theise respects (and many others that might be alleadged) will never hold, besides many yong youthes are now out of their tymes, and yerely more wil be. And if they should not be hyred what should become of them. There hath been care taken to make publique tennants of them for improving the publique lands, thereby to defray the publique charge wc'h can now bee noe further helpe, because that the publique lands are now all disposed of to the best behoofe, Soe that they must be hyred or they will live of the spoyle."

* * * * * * *

"Our governor hath been pleased to make known unto us that it is yor wills that yo'r severall tenn'ts should be very carefull in making and curing of tobacco in the house, it is true that in that care, and the tymely and opportune making up consists the greatest difficulty, but if you take from us our former allowance of that charge, great inconvenience may arise mauger the endeavors of the most endustrious, for when a season of weather serves to make up tobacco, that man comonly that hath most helpe doth make the best tobacco, wc'h if he pay all the making up out of his own pte. all men will strive to make it up with his owne family without hyring, and soe if the season be over before it be dispatched and that the wind come to north, west-north, north east, or at east wc'h is comon, all the remaynder may be spoyled."

After the Bermuda Company ceased to exist, in 1684, the cultivation of tobacco rapidly declined, and was abandoned after 1707. Agricultural pursuits of all kinds decreased, with the exception of raising oranges, which flourished for more than a century. The

change in the laws and administration, and the loss of income from tobacco, caused a great increase in maritime pursuits, and consequently in shipbuilding. During the 18th century the Bermudians engaged largely in the intercolonial commerce, and in the manufacture and exportation of salt from Turk's Island, and they pursued the sea-turtle fishery as far south as Ascension Island, and there traded with foreign vessels. During that period large numbers of vessels were built of Bermuda cedar, often 10 to 12 annually. This led to another period of deforesting. Probably most of the cedar used at that time was the second growth cedar that had grown up where the original growth had been cut down in the early period, to plant tobacco, for the Bermuda cedar, in good soil, grows fast enough to make good timber in thirty to forty years.

f.—Slavery: Negroes; Indians; Whites. Abolition of Slavery in 1834.

Slavery prevailed in the Bermudas from 1616, or earlier, up to 1834, when it was abolished. Owing to the comparatively small size of the estates, none of the planters held any considerable number, and in general the slaves seem to have been well treated,* as compared with those in other colonies, though at times severe local laws were passed for their control. During most of the history they exceeded the whites in number.

Their money value was not large and many bought their freedom, or were voluntarily freed by their owners, who were not always able to feed and clothe them properly.

But for a long series of years, free colored persons were not allowed to remain on the islands beyond a specified time† (six months or a year).

* Several instances are recorded where slaves captured on Bermuda vessels in time of war and taken to foreign countries voluntarily returned to their owners in Bermuda, when they might have had their liberty. In one such case eighty slaves taken on a Bermuda privateer, during the Revolutionary war, were taken to Boston and offered their liberty, but all except one, who died, returned to their owners. In 1828, two vessels manned by eleven slaves as sailors, arrived in Ireland, and the slaves were officially offered their freedom and protection, but only three, who were mere boys, accepted freedom.

† The following law was enacted by the Company in 1662:

"Ffor the preventing the mischiefe & danger which otherwise is like to happen by the multyplication of malattoes. Wee have Ordered that from henceforth if any malatto shall bee made free, such p'son doe within twelve months after depart the Islands." In 1704, the time that free negroes could remain was made six months.

In consequence of conspiracies or fear of insurrections, many free negroes were banished after 1650. In November, 1656, all free negroes were ordered banished at once. A proclamation of Governor Seymour, on July 26, 1664, ordered that all able-bodied free negroes and mulattoes should forthwith depart from the islands, with Capt. Stow, on a ship then ready to sail (destination not recorded). Those that did not do so were to become slaves to the Company, in all respects like slaves purchased. A law was enacted in 1674, that any colored persons brought to the islands and remaining more than 24 hours should be seized and made slaves to the Company.

The first colored slaves, one negro and one Indian, were brought from the Bahamas by the "Edwin," in 1616. Fourteen negroes were said to have been brought to Bermuda in 1616, by a pirate vessel, and sold there.

From that time forward both negroes and Indian slaves were repeatedly brought from the West Indies In March, 1660, the "Elisabeth and Annie" brought in 32 negroes from Barbadoes They were sometimes captured from the Spanish or Dutch, and sometimes they were purchased. Capt. John Wentworth, a privateer, in 1665, captured about 90 slaves from the Dutch Governor of Tortola and took them to Bermuda. In Bermuda the climate and other conditions were favorable for their natural increase, and before 1700 they even became too numerous.

Governor Butler, in 1622, referred to his "gang" of negroes, indicating their rapid increase in five or six years. In January, 1623, 14 negroes were mentioned as belonging to the "generality," and others to individuals. By that time they had, apparently, become numerous, for in that year an act was passed by the Assembly to "Restrayne the insolencies of Negroes," by which they were forbidden to carry weapons or to be out at night except by order of their masters, who were to be held responsible for thefts, etc., committed by their slaves. In February, 1629, it is recorded that Lieut. Buckley was allowed 32 slaves, and this was the regular number allowed the Governors for many years.

The following extract from one of the letters of Governor Roger Wood to the Company, in 1632, gives some idea of their numbers, at that time, and of their relatively small value, for he intimates that he had more than he wanted, or could clothe:

"And to the extent you shall see that I am not destitute of this

blacke crewe during my government, I think it fitt in this place to show you a catalogue of your negroes, men, woemen, and children, ten children and three women, lyving upon my charge, for they doe little else than to looke to theire children, for no man wil be troubled with them; neither doe I desyre recompense for the same, neither will I, so long as you cloathe them as most nobly you have done this yeare, w'ch I will cause to be husbanded soe that you shall not be deceived herein. This clothing and linen will serve I hope for next yeare also; as for this, I have put out 3 of them to masters, and after the cloathing of these will put out some others when I can fynd such masters as will be careful for their education." . . . .

"Altogether 8 men negroes, among w'ch ould Anthonio is past service, 4 woemen negroes, and 13 children." Besides this, he proceeds:—"I want 7 servants of my complete number, which I am not pressing to bee supplyed withall, as not beeing able to cloath these."

The following quaint record indicates the current value of negro women slaves in 1648, and the condition of the morals then prevailing among them. It also indicates that the Bermudians were willing to cheat the Spaniards, in a trade, if they could. But perhaps the woman was a sea-cook, at least:

"It was consented by the Gou'r and some of the councell that Mr. Sherriffe should sell Blacke Moll* one of the Company's negroes for their use, shee beinge a lazie servant and a lewde liver. Mr. Sherriffe accordingly did sell her to the Spaniards, for sixteene pounds sterling."

There are many records of the lack of employment for slaves, and of their idleness. At a later period more or less of them were sometimes sold to American planters, because they could not be profitably employed in Bermuda. Yet many of the more intelligent of the young negroes were apprenticed to learn trades, and many became good sailors.

Although the negroes were often accused of, and punished for theft and many other crimes, they seem to have rarely been guilty of murder or manslaughter. Whipping was the common punishment. Some colored men, who had been condemned to be hanged, were

* Another "Black Moll," in June, 1652, was convicted of stealing various articles (value 7lb) from two dwellings, and sentenced to be hanged. But she was reprieved on condition that she would act as the executioner, to which she agreed. She commenced by hanging a man named Worth, July 14, 1652, who was, apparently, a white man, and one who deserved hanging.

given their lives if they would become executioners.* Sometimes, for minor offences, free negroes were condemned to become slaves to the Company. This penalty was also applied, on at least one occasion, to a white man by Gov. Tucker. By a law enacted in 1668, intermarriage of whites with colored persons or mulattoes was punishable by banishment or penal servitude.

A law was passed by the Assembly, in 1730, that an owner who happened to kill one of his own slaves, when punishing him, should not be called to account, in any way; but if any one killed a slave maliciously he should pay a fine of £10, and also the price of the slave, if it belonged to another person.

On several occasions there were apprehensions of insurrections or mutinies among the free colored people and slaves against the whites. In November, 1656, such a conspiracy to kill all the whites was discovered, and nine negroes were tried and convicted. Two were executed and others were banished to Eleutheria. On this occasion, under Governor Forster, the following and other severe laws were enacted.

"(1) It is ordered that from henceforth none of the negroes of these Islands to whomsoever they do belong, or of what sort soever they are, shall have liberty to straggle or wander from their master's houses or lands after halfe an hour after the setting of the sunne, without a passe or tickett under their handes to whom they do belonge, w'ch is to be granted only upon some weighty occasion moveing thereunto. But such negroes being found stragglinge w'thout their leaves or their warrentall Tickett as afores'd, walking in the night as afores'd, it shall be at the power of any English man that meets such a negroe to kill him then & thiere without mercye. And if any such negroe shall refuse to be apprehended, and doth resist the Englishman, and he doth not make speedy pursuit against him, and shall not forthwith give information to the next magistrat, Then he or they for thier neglect therein shall forfeit one hundred poundes of tobacco to be expended upon generall service

* Cases when the same action was taken with white man are recorded in 1628 and 1631. In some cases, and perhaps generally, colored men were made executioners of colored criminals only.

A negro named John, having been convicted of stealing a boat, Aug. 17, 1664, was sentenced to be hanged, but the Governor reprieved him on condition that he should act as the executioner of negroes. Five days later "Black Mathew" having been convicted of house breaking and escaping from jail, was hanged at St. George's, and his severed head, "by the Governor's order," was impaled on a stake at Stocks Point.

(2) It is likewise ordered that the negroes that are free men and women shal be banished from these Islands, never to returne eyther by purchase of any man, or otherwise, upon payne of forfeiting their said purchase in that case."

In 1673, a "daingerous plot" was discovered among the negroes, some of whom confessed their guilt. Six were condemned to be branded or "stigmatized in ye face [forehead] with an hott iron, and their noses slitt, and whipped; and ye rest of ye negroes stigmatized and whipt." The hot iron bore the letter "R."

A conspiracy which was discovered among the slaves in 1761, to rise and massacre the whites, caused great alarm, for a time, and martial law was declared by the Governor. One negro slave, supposed to be the leader, having been convicted was burned and hanged in Warwick Parish, but the evidence against him was not very positive. Several persons were believed to have been poisoned by the slaves at that time.

During a large part of the slavery period in Bermuda, the slaves were allowed very few religious privileges and very little education, but in these respects the custom varied at different times. Many religious differences among the clergymen and sects were partly due to disagreements as to the propriety of allowing the slaves certain religious privileges, like christening, baptism,* or burial services. In the 17th century clergymen of the Established Church seem to have been generally opposed to such innovations, though there were exceptions. This reluctance to grant religious privileges continued down to the time of the abolition of slavery.

One great reason for the strenuous persecution of the Quakers, in the 17th century, was because they desired to teach the negroes.

In the official statement of the Company, in 1679, they mentioned that only about one-half the negro children were christened.

The slaves were allowed legal marriage from the first, and when man and wife belonged to different owners, they were allowed by law or custom to be together Sundays or other specified times, and their children alternately were to become the property of each owner of the parents.

In 1656, the owners of slaves were required to take them to church with themselves, wherever they went.

* It is mentioned that when the slaves had been baptized, they believed that they had thereby acquired a right to their freedom. When any funeral ceremony was held, it usually consisted in the reading of the burial service by some aged colored man.

The Rev. Samson Bond was one of the ministers who opposed the conversion of negroes. He brought a presentment against the Governor for favoring it, "and further did alleadgue that the breeding up of such children in the Christian religion makes them stubborne."

For these opinions and other reasons he was dismissed by the Company, in 1668, which, at that particular date, favored their conversion, though the colonists generally opposed it

The Rev. Samuel Smith, in 1669, brought the question before the Council, whether or not he should baptize negroes, mulattoes, and Indians, but the Council refused to decide the question.

In 1686, the Assembly passed an act against baptizing negroes.

The Rev. A. Richardson, of St. George's, stated that in 1756 he baptized 147 negroes, and in 1757, 377 more.

Indian Slaves.

Although the slaves were mostly negroes or mulattoes, some Indian slaves were also brought from the West Indies in the earlier years, and Indians, captured in the Pequot wars and King Philip's war, were sent from New England and sold as slaves to the Bermudians.*

The number of Indians held as slaves does not appear to have been large at any time. There are not many records of their arrival, and so far as appears from these there were more brought from the West Indies than from New England.

There is a record that Capt. Wm. Jackson brought many Indians and negroes, captured from the Spaniards in 1644–5, from the West Indies. It was intimated by the Company, in 1655, that 40 or more freeborn Indians had been illegally taken from the West Indies and sold in the Bermudas as slaves, about 1644–46. The Governor was ordered to free them if they could be found. The sale of 19 Indians, mostly women, is recorded in 1646, and of others in 1645; probably these were part of those referred to by the Company as freeborn. The prices were mostly from £7 to £10 each. There is also a record

* A law was passed in Massachusetts, in 1652, that those Indians who had been taken captive, or who had surrendered themselves in the Pequot or King Philip's wars, should be sold as slaves in Bermuda and other places, or else become slaves in New England. Some of these slaves appear in the Bermuda records of 1658 and later.

of some Indians returned to the West Indies in August, 1658, probably some of the same lot.

The Indians and negroes intermarried freely, but the Indians being relatively few, their descendants show but little of the Indian characteristics, though even to this day some of the negroes show more or less traces of Indian blood. Formerly many of them showed such characteristics much more decidedly. The negro slaves always increased more rapidly than the whites and they became too numerous at times, so that employment could not be found for them, while their masters found it hard to clothe and feed them. A few slaves were sometimes sold to go away from the islands. Thus the sale of 14 negroes and one Indian, to go to Porto Rico, is on record. Some were sold to Virginia. In the Royal Gazette for Jan. 17, 1784, (No. 1), Tucker & Co., of St. George's, advertised to purchase some of the "idle negroes" in order "to send them to a country where they may be profitably employed," by the ship "Queen Charlotte," then loading for Charleston, S. C.

A law was passed even as early as 1674, prohibiting the importation of any more slaves. Probably very few were ever imported directly from Africa, and perhaps none from Virginia. So far as the records show, they nearly all came from the West Indies, either by purchase, or by capture from the Dutch and Spanish.

In 1672, it was ordered that all free negroes should apprentice themselves to masters or immediately "depart the Ilands." The Company enacted a law in 1674 that any negroes brought to the islands, and remaining more than 24 hours should be seized and kept as "slaves to the Company."

It was ordained by the Company, in 1674, that the laws of England should apply equally to the negroes and whites.

When slavery was finally abolished, in 1834, the number of slaves reported was 4,026, and their value was estimated at £175,194 sterling.

White Slaves.

In the years of the early settlement, 1612–25 and later, many white persons were virtually held as slaves. Parties of women were several times sent out by the Company to be sold (for wives) to the highest bidders, or else for some definite price.

Governor Butler, writing of the arrival of the Joseph, in 1620, remarks as follows:—"In this shyp came over likewise divers newe

planters, and among them certaine young maydes (or, at the least, single women), sent over at the cost and by the pious intention (as the generall letters sayd) of some Adventurous of the Company to make wives for such single men of the country as would paye one hundred poundes of tobacco apeece for every one of them"

It is not surprising, therefore, that soon after this we read of women being often punished at the whipping posts and ducking stools, and in other ways

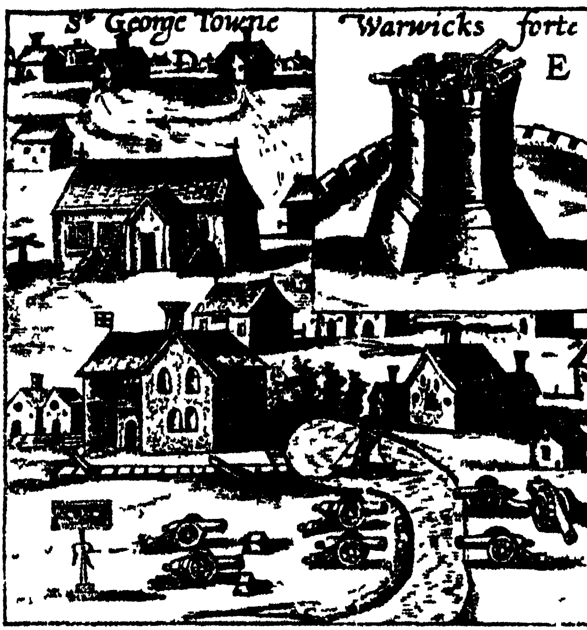

Figure 81 —Old St George's Town, in 1622, after Norwood, from a print published in 1624 by Capt John Smith, showing the Governor's House, Guns, and Stocks in the foreground, the Church near the middle, E Warwick's Fort All the roofs are thatched with palmetto leaves.

Children of poor debtors could be sold, after the death of their parents, to pay debts. Boys sent out for apprentices were often sold to the highest bidders, and were practically slaves for a term of years.

The laborers, both men and women, thus sent out were mostly a very disreputable class. They were occasionally taken from the prisons, and sometimes they were impressed from the streets, by order of the King, both for Bermuda and Virginia.

Governor Butler complained to the Company that they had treated him unfairly and unjustly in several particulars; one item is as follows:—

"Because the tenne [laborers] that were sent him out of Newgate are a burthen unto him, because the men cannot worke, and if they could he hath no ground to place them on. neither will any hire them, because they came out of Newgate. The woemen are many of them with childe and their Bastards to be be kept by him: both men and woemen are like to go naked or to bee cloathed by him."

The following passage from Governor Butler's history (1622) further shows the character of many of the early inhabitants:

"Twenty criminall prisonners brought to the barre, to the great discontent (as well as trouble) of the Governour, who plainely found thes unexpected ill fruicts of the misuse of his former wonted clemencye, that a wraunglinge and stiffnecked people, as the most of thes proved themselves (being, to say truth for the greatest part, improvidently and wreatchedly raked up out of the London kennells), wer not to be mannaged with so smoothe and gentle a snaffle as he (out of his naturall disposition) had thetherto employed, and, therefore, openly professed himselfe happy, and a glad man that he was so shortly to leave them. And the rather he became fully assured hereof, by the cryeinge and outrageous crimes, that three of these foresayd prisoners wer nowe in hold for."

Population.

The population during the first century is rarely given definitely, but can sometimes be estimated from the recorded taxes or levies of tobacco and corn. Governor Butler stated that when he left, in 1622, there were about 1,500 people.

At certain periods many persons migrated from Bermuda. Sometimes this was on account of religious persecutions, as when Eleutheria was settled in 1649 by Bermuda dissenters or Independents, who shortly after nearly starved to death and were relieved by contributions sent from New England and Bermuda, in 1650.

But in other cases it seems to have been merely because they hoped to better their condition, for Bermuda early came to be overpopulated in proportion to its resources, as they then existed.

In the "Orders and Constitutions" adopted by the Bermuda Company in 1622, article 212, it is stated that the Virginia Company had agreed to allow them a large tract of land in Virginia, on account of the small amount in Bermuda. Therefore, when Bermuda became

over-populated about 1639, and the people began to emigrate in numbers to the West Indies, the Company petitioned to the "Lords Comissioners for Forraigne Plantacons," July 28, 1639, that such a tract of land should be assigned them according to the agreement, in Virginia, between the Rapahanock and Patowmack [Potomac] rivers. In their petition they state that the people had become so numerous in Bermuda that "they are not able to subsist," that several times parties had migrated or "inconsiderately desperced themselves into other parts and especially the last yeare, when about one hundred and thirty persons have in like manner transplanted themselves into the Island of St. Luzea [Lucia] without provision or Amunicon befitting a Plantacon; where your petitioners understand that they have already both bin assaulted by the Saviges, very much sicknesse, and other descomforts, insomuch as there was not one of them in health at the date of the last ltres receaved thence."

They added that they understood that 400 or 500 more were ready "to depart the Islands, and that many more must of necessity yearely depart, by reason of the increase of the people and the straitness of the place."

The land granted is said to have been the tract still called the "Bermuda Hundred," but not the same tract mentioned in the petition. It does not appear that this effort led to any large emigration to Virginia.*

Two hundred emigrants are mentioned in the records as having sailed for Jamaica in October, 1657, on the "Golden Falcon," and 200 more, Jan. 1, 1658. Many persons also went to Barbadoes, from time to time. Richard Stafford, in his letter to the Royal Society in 1668, mentions that some of the people were then emigrating to New Providence, and some were already settled there.

Laws were very early made forbidding Quakers and Catholics to remain on the islands. The Quakers were constantly persecuted,

* Perhaps unrecorded vessels may have taken parties of emigrants to Virginia to settle on the "*Bermuda Hundred*," made famous by the civil war. There are many coincidences and similarities of family names in Virginia and Bermuda. But this may be because both colonies were settled at about the same time and by people from the same localities, rather than due to emigration from Bermuda. As an illustration of these interesting coincidences, I may cite the following case:

In November, 1650, *George Washington* was charged with treason and tried, but he appealed to the English Government. The final result is not recorded, so far as I know, nor do I know whether he was an ancestor of General George Washington, but he may well have been of the same family stock.

from the first, and many were imprisoned and finally sent away. Many Catholics were deported to Barbadoes in 1672, and others were banished at various times. So long as the islands were governed by the Company, Catholics, if known, were thus summarily disposed of. Very few, it seems, went there except in the case of shipwreck.

Capt. John Smith, 1629, stated that the population was then from 2,000 to 3,000.

In 1648 there was a levy of 17 lbs. of tobacco from every householder, making a total of 5,571 lbs. This would make 328 householders, not counting slaves. Tobacco was then reckoned at 1s 6d per pound.

In the official statement made by the Company to the Government, in 1679, the total population was put at 8,000: 400 planters; about 1,000 white men able to bear arms; births, about 120 annually (about one-half christened); deaths, about 20 annually.

Apparently the population decreased considerably after the dissolution of the Company in 1684, as did the area of land cultivated.* Probably it did not increase materially, if at all, during any part of the next century, but during most of that time it was undoubtedly much diminished; it has very much increased during the past forty years.

In 1789, the population was estimated at 10,381, of which 5,462 were white, and 4,919 negroes and mulattoes. The total in 1833 was stated at 9,195: of which 4,297 were white; 3,612 slaves;† and 1,286 free colored. In 1835, the total was officially given as 8,810: of which 4,259 were white and 4,459 colored.

The emancipation of the slaves, just before that time, apparently led to a considerable decrease in the number of the colored people by emigration, but since then they have increased more rapidly than the whites, in spite of a much higher death rate.

In 1842 there were 4,058 whites, 4,566 colored; total 8,624. The births were 130 whites, 206 colored; deaths, 75 whites, 137 colored. Ratios of deaths per 1,000: 19 whites, 30 colored.

In 1871, the total population was 12,121. According to the census of 1891, the total population was 15,013: whites, 5,960, colored,

* The amount of land cultivated in 1882 is said to have been 456 acres; in 1883, 587 acres, with 3,258 acres in pasture, feeding 1,897 cattle, 215 horses, 148 sheep, 243 goats. In 1885, 601 acres were cultivated. In 1901, according to the census returns, 2,686 acres were cultivated.

† There is a curious discrepancy here, for the number of slaves reported for emancipation and valuation the next year, 1834, was 4,026, an increase of over 400 in a year.

9,323. In 1901, the total was 17,535: whites, 6,383; colored, 11,152. Of the total number about 2,100 were living in Hamilton, and 1,000 in St. George's. These returns do not include those belonging to the military and naval establishments.

24.—*Character and Origin of the Original Flora.*

Although we have much valuable information, preserved in the early writings, as to the character of the terrestrial flora, as it existed in

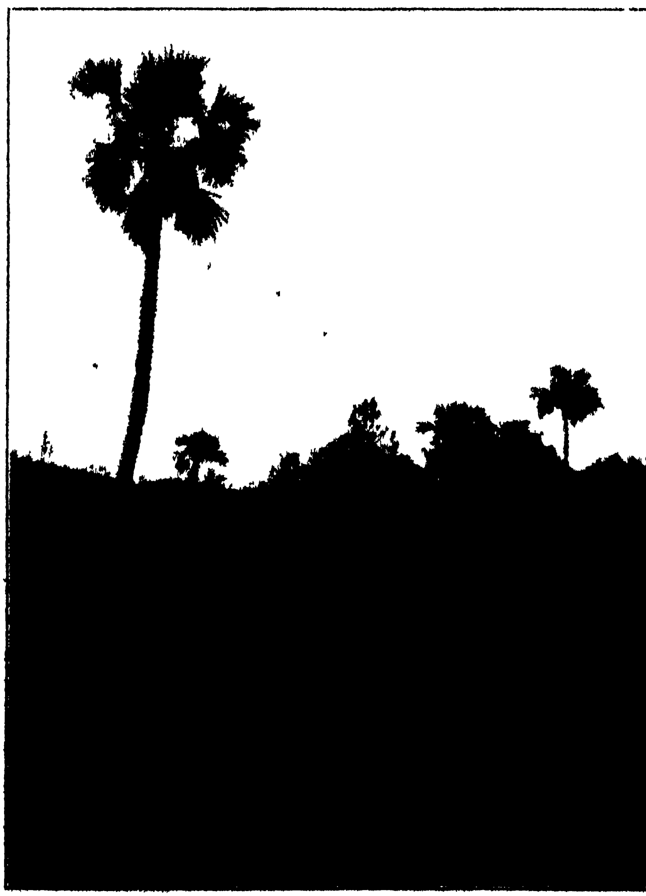

Figure 82.—Tall Palmetto growing in Pembroke Marsh. Phot. 1901.

1609–15, much the greater part relates to the trees and to a few other plants that had some direct or immediate use. It is now, of course, very difficult to distinguish, in the case of weeds and other incon-

spicuous plants, between those subsequently introduced and those that were native there before the settlement. Each case must be judged by itself, taking into account the probable chances of natural introduction, the manner of occurrence, etc

Only very few plants are peculiar to the islands, or endemic, and of these the palmetto is the only conspicuous one. (See ch. 26, *a*,

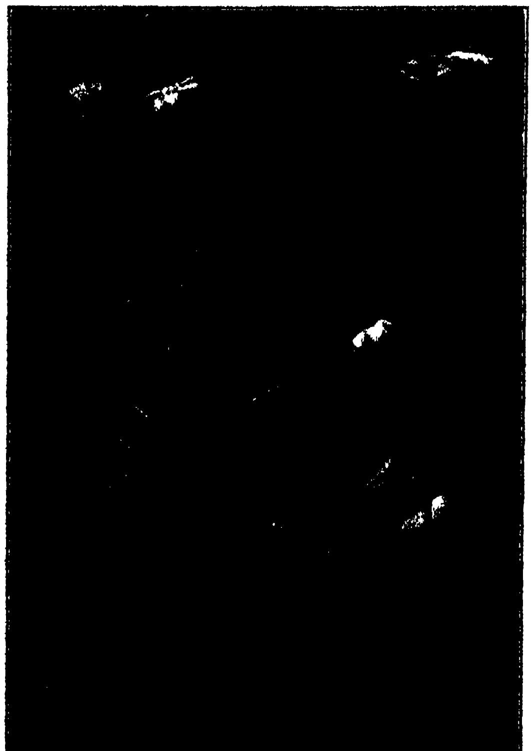

Figure 88.—Bermuda Blue-eyed Grass (*Sisyrinchium Bermudianum*)

figs. 4, 32, 39). Most of the other native plants were derived from the West Indies and the North American coastal regions.*

When the islands were first settled the flora was remarkable for the scarcity of edible plants The only herbaceous plant mentioned, that could afford any human food, was the "prickly pear" or cactus

* In naming the native Bermuda plants I have followed pretty closely the nomenclature used by Hemsley, in Voy. Chall., Botany, vol. 1.

(*Opuntia*), which still grows abundantly on the barren cliffs by the sea. Its berries were eaten, both raw and cooked, by the early settlers. There are no fruits mentioned, except the berries of the palmetto, cedar, and wild mulberry, although a few shrubs, with more or less edible berries, still exist that were probably native.* But the settlers may not have known that they were edible or they may have been so scarce that they were of no importance to them.

Figure 84.—Bermuda Maiden-hair Fern (*Adiantum bellum*).

The list of existing flowering plants and ferns, believed by the writer to have been native of the islands before their settlement, includes about 156 species; of which 22 species are ferns. Of the whole number, about 120 species are also native of the West Indies.

a.—Endemic Plants.

Five flowering plants and three ferns are generally believed to be endemic, since they have not yet been found elsewhere, but some of these may eventually be found in the West Indies, when those islands shall have been fully explored botanically. Yet it is possible that some of them, which may have originated in the West Indies, have

* The Sea-side Grape (*Coccoloba uvifera*) and the *Myginda rhacoma* bear berries that are said to be edible, but perhaps not very palatable. These are supposed to be indigenous, though neither is mentioned by early writers.

been exterminated there, by human agency, before disappearing in Bermuda

Aside from the Palmetto, the most interesting of these endemic species are the Blue-eyed grass and the Maiden-hair Fern, both of which are very common and widely diffused

The Blue-eyed Grass* or "Lily" (fig. 33) grows in a variety of situations, both in good soil and on barren rocky and sandy hills, and even on the small barren islands. Its bright blue flowers, which are produced in abundance in spring, are often at least one-half an inch in diameter, being much larger and brighter blue than those of our New England species. The flower stems are often 8 to 10 inches high, but shorter in dry soil.

The Maiden-hair Fern (fig. 34) grows in abundance in the cracks and crevices of cliffs, especially in those of the stone cuttings along the roadsides, forming tufts of very elegant and graceful foliage.

The endemic species, according to Hemsley (Voy. Chall., Botany, i, p. 12) are as follows:—

Flowering plants:—

Erigeron Darrellianus Hemsl.
Statice Lefroyi Hemsl. Sea Lavender.
Sisyrinchium Bermudianum L Blue-eyed Grass Fig. 33.
Sabal Blackburniana Gl. Bermuda Palmetto. Figs. 4, 32.
Carex Bermudiana Hemsl.

Ferns:—

Adiantum bellum Moore. Maiden-hair Fern. Fig. 34.
Asplenium Laffanianum Baker.
Nephrodium Bermudianum B.

b.—*Localized Plants.*

Among the 156 species of land plants now considered native†, about 50 species are very restricted in their distribution, having been found

* An ancient law, passed in 1669, required the destruction of two bad weeds, the "Wire-weed" and "Lily" It is thought that this Blue-eyed Grass was the plant meant by "Lily," because there is no other native plant or weed that resembles a lily. If so it would prove that it was more abundant at that time than now, which is not unlikely.

† Hemsley reckoned 152 species as native (including eight species added in the Addenda). Lefroy considered a considerable number of additional species as native, some of which were more probably introduced. The additional species, introduced by man and considered as fully naturalized, are about 190, though many more are partially naturalized. So that the total number of flowering plants and ferns is about 350, exclusive of exotic cultivated plants, not naturalized. To these may be added about 8 mosses; 6 Hepaticæ; 32 lichens; 32 Fungi. The algæ include about 140 species.

in but one or two localities; 34 of these are either found only in the Walsingham district, or rarely elsewhere. This seems to be one of the few limited tracts that have never been entirely cleared of the trees, nor burned over. Owing to the large amount of rocky and rough places and ragged ledges, where the patches of good soil are of very limited extent, considerable tracts of land on this estate appear never to have been cultivated, so that the primitive vegetation has escaped destruction more than in any other tract.

Most of those so restricted are of West Indian origin, but the *Ampelopsis* is the common American woodbine, and the *Celtis* is that of the eastern United States. Nine of these are ferns, viz.:

Aspidium aculeatum.	*Asplenium Laffanianum.*
Nephrodium amplum.	*A. rhyzophyllum.*
N. Bermudianum.	*A. dentatum.*
Polypodium pectinatum.	*Pteris heterophylla.*
Polypodium elasticum.	

One belongs to the Lycopodiaceæ (*Psilotum triquetrum* Sw.); like the ferns, it occurs about the mouths of caves; also on the shore cliffs.

Fourteen are trees and shrubs, viz.:—

Chiococca racemosa. "Blolly"; "Snowberry; David's Root." Flowers white or yellow.	*Cæsalpinia bonducella.* (*Guilandina*, in Lef.) "Nicker Tree" Rare.
Dodonæa viscosa. "Broom"; "Dogwood." (See p. 580.)	*Psychotria undata* Jacq.
Dodonæa angustifolia Sw. Recorded by Grisebach, 1864. A widely distributed tropical shrub.	*Morinda royoc* L. Yaw Weed.
Elæodendron xylocarpum. Olive-wood Bark. (See ch. 26, *d.*)	*Sponia Lamarckiana* Decs.
Eugenia monticola (= *E. axillaris* Lef.) "Stopper; Rod Wood."	*Celtis occidentalis.* Nettle Tree.
Forestiera porulosa. "Wild Olive"? (See ch. 26, *d.*)	*Triumfetta semitriloba.* Burr-bush; Burr-bark; Box-bush.
	Hibiscus tiliaceus. "Mahoe." A malvaceous tree. (See p. 579.)
	Zanthoxylum aromaticum. "Yellow-wood Tree." Rare. (See ch. 26, *c.*)
	Jatropha curcas. Physic-nut.

The following are vines:—

Ampelopsis quinquefolia. "Woodbine."	*Ipomœa purpurea.* Morning Glory. (Introduced?)
Cardiospermum halicacabum L. Small Shot. Also in Devonshire Marsh.	*Passiflora ciliata.* Wild Passion-flower; "Apricot."
	Sicyos angulatus. Wild Bryone. (Introduced?)

The remainder are as follows :—

Spermacoce tenuior Lam. Button Weed. Annual.

Arenaria alsinoides Willd.

Callicarpa ferruginea. "Turkey-berry."

*Peperomia magnoliæfolia** (=*P. obtusifolia* in Lef.) A succulent-leaved plant. Fig. 35.

Statice Lefroyi Hemsl.=(*S. Caroliniana* Lef) Sea Lavender. (Endemic.)

The last named species and two of the ferns appear to be endemic. It is not improbable that the *Ipomœa* and the *Sicyos* were both introduced by man, though there is no evidence of this. Lefroy considered them native. The White Jasmine (*Jasminum gracile*), which thickly covers the rocks and drapes the cedars to their very tops, in parts of this tract, is known to have been introduced there about a century ago, but it has not spread elsewhere to any marked extent. Hemsley also classed the *Passiflora* as an introduced species, but without any particular evidence.

A few species were found only on Boaz Island, about twenty-five years ago, in a place that had not then been much disturbed. Whether they still exist there is not known. Several species, mostly ferns, are not known to occur except in some particular spots in some of the marshes, especially in Pembroke Marsh. Many of these very localized species will probably disappear before many years. One endemic species of sedge (*Carex Bermudiana* Hemsl.) is known only from specimens collected, about 1699, by John Dickinson (Sloane Herb.). It may now be extinct.

Among the plants entirely restricted to certain marshes, or nearly so, or to other limited localities, are the following :—

Waltheria Americana L. Pembroke Marsh. A shrubby, downy plant 2–3 feet high, with clusters of small yellow flowers. In all tropical countries.

* Hemsley states that the correct name of the Bermuda plant is somewhat uncertain. My photograph shows that it does not agree well with the descriptions of *P. magnoliæfolia* and *P. amplexicaulis* (considered varieties of one species by him and others), for both these West Indian forms are described as having sessile or subsessile leaves, while they are petiolate in the Bermuda plant. A specimen labelled as *P. magnoliæfolia*, from southern Florida, in the Eaton herbarium, agrees in this respect with the Bermuda plant. Some of the several Cuban forms of *P. obtusifolia*, in the same herbarium, which I have studied, have petiolate leaves of the same form as those of the Bermuda variety. Therefore the latter may rather belong to a variety of *P. obtusifolia*, if this be really a distinct species. But in that case the Florida form probably belongs to the same variety.

Melochia odorata L. Pembroke Marsh. A rare tree; native of the Pacific Islands.

Pluchea camphorata DC. Marshes.

Pluchea odorata Cass. Marsh Flea-bane; Wild Tobacco. Pembroke Marsh. A composite shrub. West Indies; Central America.

Pluchea purpurascens DC. Shelly Bay Swamp and near Warwick Pond. Annual. Florida; Mexico; West Indies.

Kosteletzkya Virginica Presl. Pembroke Marsh. A rare, East-American, herbaceous, malvaceous plant, 2–4 feet high. The lower leaves are mostly ovate or cordate and three-lobed, upper ones entire. Flowers purple, in terminal racemes.

Figure 85.—*Peperomia magnoliæfolia* (?); Bermuda variety. From life.

Pavonia spinifex Cav. Burr Bush. Southampton only.

Sapindus saponaria L. Soap-berry Tree. Rare. The black seeds, which are very hard and sometimes used for beads and buttons, are not affected by soaking in the sea.

Myginda rhacoma Sw. A shrub with small, opposite, leathery leaves, and a small, obovate, edible berry, ripe in January. Flowers small, four-parted, in axillary, peduncled cymes. Only in Southampton Parish. Florida and West Indies.

Sophora tomentosa L. Boaz Island and South Shore. A leguminous tree.

Ludwigia repens Swartz. Found only in the peat bogs. Also native in South Carolina, Texas, West Indies.

Randia aculeata L. Box Briar; Indigo Berry. Warwick and Paget. (Introduced?)

Spiranthes tortilis Rich. Pembroke Marsh. The only native orchid of the Islands.

Paspalum distichum L. A grass found in the swamps; widely diffused in both hemispheres.

Ferns, etc.:—

Woodwardia Virginica Sm. Pembroke Marsh.

Aspidium coriaceum Sw. Devonshire Marsh.

Nephrodium thelypteris Des. Pembroke Marsh.

Equisetum Bogotense Kun. (?). Pembroke Marsh.

c.—Sea-side Plants.

A considerable proportion of the native plants of the Bermudas, and some of the introduced ones, are true sea-shore plants, preferring to live within reach of the spray, or even with their roots immersed in brackish water, and in some cases, like the Mangrove and Black Mangrove, growing in clear sea-water.

Many plants of this kind produce hard seeds that retain their vitality after floating for weeks or months in the sea, and have thus acquired a very wide distribution on all tropical coasts.

Several that are here enumerated grow chiefly on the sand-dunes near the shore and help to bind and fix the drifting sands, and are thus very useful. Others grow in crevices of the exposed shore cliffs and serve to somewhat relieve their rugged and barren appearance, while a large number grow only in the salt marshes, or swamps. Certain species, like the *Opuntias* or Prickly-pears, grow equally well on the shore cliffs and on the ledges by the roadsides.

In general, it is probable that these sea-side plants have not been very much diminished by the advent of man, for they mostly occupy land that cannot be cultivated or used for other purposes, aside from the town and village shores. But it is probable that some of those that grow on high shores have been much diminished by the pasturing of goats and sheep, while some of the larger shrubs and trees, like the Mangroves, have been cut away for fuel, etc.

Some of the more conspicuous or important of these species will be discussed in a later chapter, under Deforesting. The following list is intended to include those native species that are particularly partial to the shores, or scarcely to be found elsewhere, but not all those that may be found growing on, or near the shores, nor those

that are known to have been introduced by man. Some of the larger shrubs might be much more extensively used than they are for windbreaks against the salt spray and sea-foam* along exposed shores. The "Sea-side Grape" (*Coccoloba*) is well adapted for this use. The Mangrove and Black Mangrove are of great value in protecting certain shores from erosion by the sea, as well as against winds, while their peculiar roots serve efficiently to entangle vegetable debris and silt, and thus add to the extent and fertility of the shores.

Scurvy Grass. (*Cakile æqualis* L. H.)

Common on the shores. Also on the southeastern coast of the United States and in the West Indies. Sometimes cooked and eaten, as greens, by the natives.

Mahoe. (*Hibiscus tiliaceus* L.=*Paritium tiliaceum* Juss.; Gris.)

A large malvaceous tree, with large heart-shaped leaves, gray below. It is found on most tropical coasts. A fine tree grows at Somerville; a few at Walsingham and elsewhere; not common. It has been raised from seed cast ashore at the islands. Found on nearly all tropical coasts.

* Much of the damage done to vegetation by the winds near all sea coasts is due to masses of sea-foam, caught up from the shores, where it is formed by the waves, even in moderate gales, and carried inland, often to long distances. Lodging on leaves and branches, it kills or damages those plants that are not immune, unless at once washed off by rain.

In my own experiments, during more than fourteen years, in setting out trees and hardy herbaceous plants on a small island in Long Island Sound, I have often lost every specimen of certain species of herbaceous plants and trees from this action of sea water in a single dry wind-storm, even after they had lived and grown well for years in the same places.

In the severe hurricane of Aug. 25, 1893, nearly all the native shrubs and deciduous trees, as well as many cultivated ones, were killed by the foam and spray, including Hickory Trees that were over 60 years old and up to a foot in diameter. The native Red Cedar, Pitch Pine, Japanese Privet and Elæagnus, Bayberry, and Poison Ivy were least injured, but the last two lost their foliage and were partly killed, nearly to the ground. Had rain continued to the end of the storm, so as to wash away the salt foam, little injury would have been done.

This single storm, therefore, was sufficient to have exterminated many native species of plants on islands of considerable size. On this occasion the salt spray and foam seriously damaged the foliage of forest and fruit trees on the mainland, even several miles from the shore. A white film of salt was observed on the leaves of trees fifteen to twenty miles from the sea.

Tassel Plant. (*Suriana maritima* L.)

A peculiar shrub, 4 to 5 feet high, belonging to the Simarubeæ, found on the tropical coasts of America and most other countries. The leaves are crowded distally, downy and fleshy, small, linear-spatulate; flowers yellow, in small clusters or short racemes. Hungry Bay, and other places on the south shores

Dogwood ; Broom. (*Dodonæa viscosa* L.)

On the coasts of most tropical countries in dry barren places. Belongs to the soap-berry family. A shrub 6–8 feet high, with oblong or obovate, entire, viscid leaves, and short racemes of apetalous flowers.

The Soap-berry Tree (see previous list) is a true sea-side species.

Nicker Tree. (*Cæsalpina bonducella* L.= *Guilandina bonducella* Lef.)

A trailing, prickly, leguminous sea-side shrub found on most tropical coasts, arising from large, hard, lead-colored floating seeds.* Walsingham, rare.

Bay Bean ; Sea-side Bean. (*Canavalia obtusifolia* DC.)

A native sea-side vine, with rose-colored flowers, found on most tropical shores, its brown seeds retaining vitality after long immersion in the sea. The leaves are trifoliate. The pods are 4 to 5 inches long and about an inch wide.†

Sea-side Bean. (*Vigna luteola* Benth.)

An American sea-side vine, but found on many other tropical coasts, like the last. The flowers are yellow, in axillary racemes.

Sea-side Locust. (*Sophora tomentosa* L.)

A leguminous shrub, 4 or 5 feet high, with pinnate, downy gray leaves, and yellow showy flowers; found on nearly all tropical sea-shores, owing to the vitality of its sea-drifted seeds. Smith's Island and South Shore ; not common.

* Known as bonduc-seeds or Molucca beans, used in India as a tonic and febrifuge.

† This is supposed to be the vine referred to by Capt. John Smith (Hist. Virginia) as follows: "A kind of Woodbind there is likewise by the sea, very commonly to be found, which runnes upon trees turning itself like a Vine: the fruit somewhat resembles a Beane, but somewhat flatter, the which any way eaten worketh excellently in the nature of a purge, and though very vehemently, yet without all perill." I do not know whether this plant has such properties; the seeds of some species of the genus are edible.

White Mangrove. (*Laguncularia racemosa* Gært.)

A combretaceous shrub found also on the tropical shores of America and West Africa. Flowers small, in lateral and terminal spikes. Leaves opposite, smooth and fleshy.

Sea Mulberry; Button Tree; Zaragoza Mangrove. (*Conocarpus erectus* L.)

Common on most of the shores. Also in the West Indies and Florida. A combretaceous shrub, with lanceolate, alternate leaves and angular branchlets; flowers and fruit crowded in small heads; flowers very small, greenish. (See ch. 26, *d.*)

Mangrove. (*Rhizophora mangle* L.)

FIGURE 42. PLATE LXXIV; FIGURE 1 PLATE LXVIII; FIGURE 2.

The true Mangrove still grows luxuriantly in many of the salt swamps and in the upper parts of some inlets and coves, as at Hungry Bay, Mangrove Bay, etc. (See ch. 26, *e.*)

Prickly Pears. (*Opuntia vulgaris* Mill.; *O. tuna* Mill.; *O. pes-corvi* Lec; and *O. ficus-indica* Mill.)

These four species of *Opuntia* are not easy to distinguish. Some have much longer spines than others; few and small in the last named; 4 or 5 stout ones in each cluster in *O. tuna.* They are abundant on the barren sea-side cliffs and small islands, as well as on the walls and cuts along the roadsides.

Whether all these species were originally native is not known. Prickly Pears were used as fruits to a considerable extent by Somer's party, and by the earliest settlers, in 1609 to 1616, before better fruits were introduced. The flowers of all are large and yellow; the fruits reddish, at least on one side when ripe; pulp red.

Sea Purslane. (*Sesuvium portulacastrum* L.)

A common, native, succulent, sea-side plant, growing in moist places. It is found on most tropical coasts. Resembles purslane, but has small, rosy, apetalous flowers in September. The common Purslane also grows here by the sea-side.

Ear Wort. (*Rhachicallis rupestris* DC.)

Among rocks along the shores; a ragged-looking shrub, with small leaves, belonging to the Rubiaceæ. West Indian. It is the *Vaillantia muralis* of Lefroy.

Wild Box; Ink-berry; Indigo Berry; Box-briar. (*Randia aculeata* L.)

A spiny rubiaceous shrub with small, smooth, obovate leaves, large fruit, and white axillary flowers. It is found on the sand dunes; abundant in some places in Paget parish. Also in Florida and the West Indies.

Sea Oxeye; Yellow Daisy-bush. (*Borrichia arborescens* DC.)

FIGURE 36.

Figure 36.—Yellow Daisy-bush (*Borrichia arborescens*).

A common, native, composite shrub, growing in thick clumps in dry barren places on the shore cliffs. It varies greatly in foliage, or there may be said to be two varieties. Some of the clumps have all or nearly all the leaves thickly covered with downy or silky hairs, giving them a pale gray, hoary appearance; while other clumps, close by, may have all their leaves glossy and bright green; but intermediate states also occur. The leaves are thick and vary greatly in form on the same plant, some being narrowly linear, others lanceolate or obovate. The flowers, which appear in April and May, are like a yellow daisy, about an inch across, and the investing scales are obtuse, without a sharp point. It ranges from Florida and the West Indies to South America; also in Peru.

Smaller Sea Oxeye; Sea Marigold. (*Borrichia frutescens* DC.)

This resembles the preceding and grows in similar places, but is less common. It ranges from North Carolina to Mexico. Its leaves are gray and downy or hoary, and the flowers are less conspicuous

than in the preceding. It can easily be distinguished by the sharp tips to the scales of the involucre, and by the prominent spinose tips to the chaff, on the disk.

Lefroy did not distinguish the two species, but both are figured by Hemsley in Voy. Challenger, Bot., i, pl. ii, iii.

Sea-side Golden-rod. (*Solidago sempervirens* L.)

This fine golden-rod, which is the same as the common one of the New England coast, is very common about high-water mark, and a little beyond it. It is not injured by the partial daily immersion of its roots in sea-water, nor by salt spray. Found also in the Azores.

Dog-bush; Groundsel Tree. (*Baccharis glomeruliflora* Pers.=*B. heterophylla* in Lefroy's list.)

This composite shrub is abundant and apparently native in Pembroke Marsh and probably elsewhere. It is found on the salt marshes of the American coast, as far north as North Carolina. Flowers white, appearing at Bermuda in December (Lefroy). The ripe seeds have a long downy pappus.

Black Berry. (*Scævola lobelia* L.)

FIGURE 87. PLATES LXXV; LXXVI

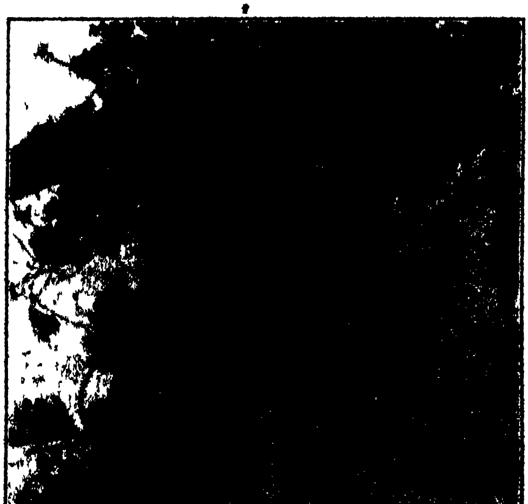

Figure 87.—Black Berry Shrub (*Scævola lobelia*), on the Sand-Dunes.

This native shrub is one of the most important plants for binding the drifting sands on the sand-dunes close to the sea, as at Tucker's

Town, where few other plants will grow. Its stems are straggling, crooked, and more or less procumbent, and its thick, leathery, smooth, obovate leaves, which grow in close terminal tufts, seem to be proof against the injurious effects of salt spray

It bears rather curious white flowers, looking as if slit open on one side The berries are as large as a small grape, smooth, black, and have a very disagreeable taste The juice makes a nearly indelible black stain, and is said to be sometimes used for marking linen

It is also native of the tropical coasts of America, Africa, and Asia.

Sea Lavender. (*Statice Lefroyi* Hems)

Hemsley, Voy Challenger, Bot , i, p 47, pl iv

Salt marshes at Walsingham. Endemic

Sea Turnstole. (*Heliotropum curassavicum* L.)

A native plant growing on the salt marshes. It bears twin flower-spikes, curving over in opposite directions

Sea Lavender. (*Tournefortia gnaphalodes* R B.)

FIGURE 88

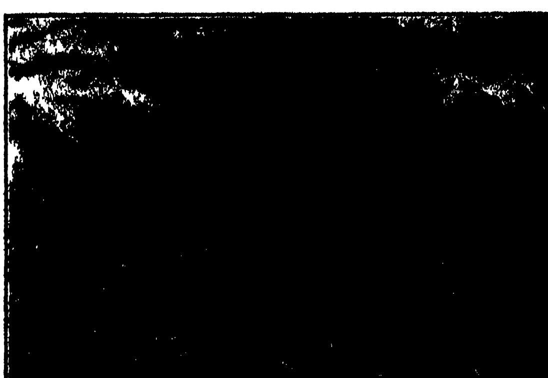

Figure 88.—Sea Lavender (*Tournefortia gnaphalodes* R B.)

A native shrub, common on the South Shore near the sea. Its leaves are silky and hoary-gray, narrow, elongated, and are crowded toward the tips of the branches. The flowers are white or pinkish, in small, downy, one-sided, curved spikes. The corolla is 5 or 6 lobed, fleshy and plicate, downy outside.

Gromwell. (*Lithospermum distichum* Ort.)

Found only by the sea-side, probably native. A plant of Mexican origin.

Sea-side Vine. (*Ipomœa pes-capræ* Sweet).

A very common native vine growing close to the sea-shore and on the sand-dunes, where it is useful in binding the sand. The leaves are roundish and fleshy. Flowers purple; two inches long.

Black Mangrove; Olive Mangrove; Black Jack. (*Avicenna nitida* Jacq.)

FIGURE 43. PLATE LXXIV, FIGURE 1.

An evergreen native tree, of the Verbena family, very common in the mangrove swamps, associated with the true mangrove. Found also on the tropical coasts of America and Africa. It resembles the mangrove in size and foliage.

Sea Orache. (*Atriplex cristata* H. B.)

A grayish, erect, sea-side shrub, common on the North Shores. Widely distributed on the tropical American coasts.

Glasswort; Samphire. (*Salicornia fruticosa* L.)

Abundant in salt marshes. Widely distributed.

Sea-side Grape; Grape Mangrove. (*Coccoloba uvifera* L.)

PLATES LXXXI–LXXXIII.

This curious polygonaceous tree is common along the South Shore, just above high-water mark, where it forms a good windbreak in many places, as near Hungry Bay. It sometimes grows also in the marshes.

It seems to be nearly immune against the poisonous nature of salt spray. Indeed, in many places the great waves of the September, 1899, hurricane swept directly over and far beyond the row of Sea-side Grapes, often laying bare many of their roots, and breaking their branches, but yet without killing them. It might be set out to advantage in many other exposed situations.

When old there may be a short, stout, basal trunk or root-crown, two to four feet in diameter (sometimes 21 feet in circumference and two or three feet high, according to Lefroy), from which a number of stout trunks, sometimes six or seven, arise in a cluster, some of

which may be a foot or more in diameter, but seldom more than 15 to 20 feet high. It yields the astringent drug, "kino."

Its leaves are thick, leathery, rounded or heart-shaped, and often 5 to 6 inches across. Its berries are purple and grow in clusters; probably their appearance gave rise to the English name. Matthew Jones stated that the berries were eaten raw by school children. They are sometimes used for preserves, but do not seem to be much valued. Widely distributed from Florida to Brazil.

Euphorbia buxifolia Lam.

Common in crevices of the cliffs and in rocky places along the shores. Leaves oval, pointed, crowded and overlapping on the stems. It ranges from Florida to Venezuela and the West Indies.

Croton maritimus Walt.

A grayish or hoary herb, 2 to 3 feet high, with thick, ovate, roundish, or slightly cordate leaves, on long petioles; flowers small, in spikes. Common on the sand-hills near the shore. Ranges from North Carolina to Venezuela and the West Indies.

Eel Grass; Turtle Grass. (*Ruppia maritima* L. and *Zostera marina* L.)

Both grow in shallow sea water. (See p. 448.)

Crab-grass. (*Stenotaphrum Americanum* Schr.= *S. glabrum* in Lefroy.)

The most abundant native grass; it grows in all dry and rocky places by the sea-side and on the cliffs, and also in the interior. It forms depressed or flattened rosettes of leaves close to the ground, and sends out rooting stolons, often several feet long, in every direction. These may often be seen hanging down over the edges of cliffs and of rock cuttings along the roads, swinging with the wind and ready to take root in any crevice.

Burr Grass. (*Cenchrus tribuloides* L.)

A common grass on the sand-dunes and one of the most useful of the plants for binding the sand.

Sea Grass. (*Spartina juncea* Willd.)

Ireland Island, in the edge of the sea. A tall grass which grows in similar places, from Canada to Florida.

Drop-seed Grass. (*Sporobolus Virginicus* Kunth.)

A common grass on the sand-dunes; one of the important sand-binding plants.

Sea-side Club-moss. (*Psilotum triquetrum* Sw.)

The only native lycopodiaceous plant on the islands. It grows among rocks near the shore at Walsingham and Ireland Island; not common.

Widely distributed on the tropical coasts of both hemispheres.

d.—Origin of the Native Flora.

All the native plants, except about eight that seem to be endemic, were originally native either of Northeastern America or of the West Indies and the Southeastern United States, from whence they were introduced by natural agencies prior to the advent of man. Migratory birds have probably always been the chief agencies for these introductions of plants, especially of those from Northeastern America, for large numbers of birds fly from New England and Nova Scotia directly to the Bermudas every year in their autumnal migrations. They can, therefore, readily convey hard, indigestible seeds in their digestive organs for the brief period that this journey would require, for at the common rate of 40 miles an hour, it would require less than 20 hours to make the trip. Small seeds of many kinds may be carried adhering to the feathers, or contained in mud adhering to the feet of aquatic birds.

During the spring migrations seeds could be brought from the West Indies in the same ways, though the distance is somewhat greater.

No doubt seeds of numerous species are thus annually carried in these ways from New England and Nova Scotia to the Bermudas, but of these only a very small fraction would be likely to fall in places suitable for their germination, and of those that might germinate, very few would find the soil and climate suitable for permanent growth. Some might be able to live for several favorable seasons, and then be exterminated by a season of unusual drouth, just as is the case with many plants intentionally planted. Very few of our northern hard wood trees and fruit-bearing shrubs will grow in Bermuda.

Although it is probable that fewer seeds are brought from the West Indies by birds, the climate and other conditions are much

more similar there, hence a much greater per cent. of West Indian plants would be able to establish themselves.

Many tropical plants produce large seeds or nuts with such hard and impervious shells that they can float in the sea for many weeks, or even months, without injury. Seeds of certain West Indian plants cast ashore with seaweeds on the coast of Bermuda, in recent times, have been seen to germinate and grow there, as the Soapberry Tree (*Sapindus saponaria*), the Mahoe, etc. Many true seaside plants have seeds of this kind and have thus acquired a very wide distribution.*

Floating decayed drift-wood, or drifting trees with roots and earth adherent, having drifted northward in the Gulf Stream, may then have been cast upon the Bermuda shores by the prevailing southwest winds, thus bringing seeds, insects in the pupa state, reptiles, snails, earthworms, etc. Such cases have occurred in modern times.

Possibly many minute, light seeds, and some small winged seeds, may have been carried as far as Bermuda in gales of wind, or in hurricanes. But plants having downy pappus on the seeds, or with regularly winged seeds, were not numerous in the native flora. The spores of ferns and mosses can thus be carried long distances by the wind, which accounts for their wide distribution.

Of the 156 species of flowering plants and ferns that appear to have been natives, about 115 species inhabit also the coastal regions of North America, much the larger part of these being found in Florida, but some also occur in New England. Among these the Bayberry (*Myrica cerifera*) is very noticeable in the marshes. Its seeds are eaten by many birds, including the yellow-rumped warbler and the catbird.

About 118 of the species are native of the West Indies, and of these about 90 species are also found in Florida or adjacent parts of North America, but they are probably of West Indian origin. About 28 species are West Indian, and not found in Florida, and about the same number are of North American origin and not found in the West Indies.

In the last named group are the Nettle-tree (*Celtis*), the Woodbine, and the "Poison ivy" (*Rhus toxicodendron*). The latter is still very common and was mentioned by the earliest settlers as "the poison weed." Governor Butler, in 1619, gave a good description

* Hemsley (op. cit , p. 48) enumerates about 45 species of the native Bermuda plants, in his list of those that have such seeds.

of it and its poisonous effects. Its seeds, which are very hard, are eaten by many birds, especially by the Catbird, and in this way it could easily have been carried to Bermuda. About 50 species of the native plants have a wide distribution, occurring in the Old World as well as in America.

In the chapter on geology I shall endeavor to show that most of the earlier plants and animals of the Pliocene Period were exterminated in Bermuda during the Glacial Period, owing to the distinctly colder climate and the frosts that must have prevailed, at that time in winter. Thus most of the plants of the present native flora have arrived here since the Glacial Period. The few endemic species, and some of the others, probably survived the Glacial Period, because they were able to endure the lower temperatures and some frost, or because they grew in very sheltered places, like the sinks due to fallen caverns. Probably the Flora in the pre-glacial periods may have been more tropical than the present one.

25.—*Destructive Effects of the Wild Hogs, Wood Rats, Snails, Slugs, etc.*

a.—Effects of the Wild Hogs.

Before the settlement of the islands the wild hogs had become very abundant. Henry May, in 1594, spoke of their leanness, for lack of food, in the winter season, when the cedar and palmetto berries were gone. It is probable that those herds of wild hogs had even then been on the islands for many years, and that they had eaten up or destroyed nearly all the native, edible, herbaceous plants long before the arrival of the settlers. This would account for the absence or rarity of plants having edible roots or herbage. The trees and shrubs having roots that they could eat would also have been damaged or exterminated, for wild hogs, when nearly famished, will root out and destroy the roots of many trees and shrubs that, at other times, they will not disturb.*

* In the pine barrens of North Carolina I have formerly seen, in winter and early spring, large areas of pine lands where the half-wild hogs had dug up the roots of the pitch-pines, even of the larger ones, and had eaten the bark entirely off many of the upper roots. The ground under the trees looked, in many cases, as if it had been ploughed up in every direction, over large areas. The smaller trees were often overthrown and killed, while the larger ones were much damaged.

It is highly probable that various plants with edible fruits or seeds had existed there previously, of which we know nothing; some of them may have been endemic; the seeds of others may have been brought by the birds, like most of those that survived. In fact, the migratory birds are more likely to have introduced plants having edible berries and hard seeds than any others.

Possibly a future study of the plant remains buried in the deeper peat-bogs may reveal some of the plants that originally grew in the islands, but were exterminated by the hogs and wood-rats.

b.—*Effects of the Plague of Wood-Rats, 1614–1618.*

The hordes of wood-rats that appeared and overran the islands in 1614–1618, just about the time that the wild hogs were exterminated (see ch. 33, *b*), must also have destroyed vast numbers of plants and their seeds. The settlers were unable to raise any edible crops, at that time, on account of their ravages, but the rats, evidently, did not eat the tobacco crop. Their habit of ascending the highest trees would have enabled them to destroy all the berries of the palmetto and cedar, and all other edible wild fruits and seeds. They may have totally exterminated many plants that had escaped the hogs. Probably their final, very sudden disappearance was due to starvation, after they had destroyed all available food. (See ch. 33, *b*.)

It seems probable, therefore, that the remarkably small number of indigenous plants, at the time of the early settlements, was owing, to a very considerable extent, to the effects of the hogs and rats. Probably, also, part of the native plants that have become very localized, as at Walsingham and in the marshes, were among those nearly exterminated at that time.

The subsequent altered conditions of the land, owing to deforesting, burning, and cultivation, may well have been sufficient to prevent their subsequent diffusion, and many such species, left in small numbers, may have gradually died out during the subsequent three centuries, because of changed conditions.

Several of those that are still left are apparently on the verge of extinction, for they have constantly decreased in their range and numbers during the past thirty years, or ever since they have been studied, and perhaps some of those enumerated above are already extinct.

Probably many species of birds, reptiles, insects, snails, etc., were also exterminated, at the same time, by the hogs and rats, for both

will eagerly devour the eggs and young of birds, insects, reptiles, and any other animal food that they can find, when food is scarce, and they are half-starved. The early writers told of the boldness and voracity of the rats in killing chickens, and even entering their houses and eating their clothes, showing that they were unable to find more natural food and were nearly starved, for they do not ordinarily enter houses.

At such times they probably girdled and killed many trees with edible bark, as other rodents are apt to do.

c.—Effects of Injurious Insects; Snails and Slugs.

That large numbers of injurious insects were introduced by the settlers, from time to time, is certain. Some of these, like the scale-insects, are capable of killing trees and even of exterminating species of plants over a limited area like the Bermudas.

The rapid destruction of the orange and lemon trees by scale-insects, in modern times, is a good example of their destructive powers. But we know too little of the Bermudian insects and the effects that they may have produced on various plants, to warrant any lengthy discussion of the subject in this place.

In the chapter on insects, the most important injurious species will be discussed, with their habits. So far as known the scale-insects have been the most destructive here, especially to the citrus fruit trees, figs, etc. (See ch. 37, *j.*)

Most of the larger slugs and snails have been introduced by man. The most injurious of all these is the "spiral snail" of the Bermudians (*Rumina decollata*), which was first introduced accidentally in 1877, at Mt. Langton, Hamilton, but it has increased prodigiously and has now spread all over the Main Island, doing a very great amount of damage to the crops. They have here few natural enemies to check their rapid increase, though the Tropic-bird has learned to eat them. (See ch. 36.)

Whether such snails and slugs are capable of exterminating any wild and common species of plants may be doubted by many, but they are certainly capable of interfering with their growth and changing the ratios of various species of plants to each other, and they might easily destroy rare species, or even some of the more common ones, in case the foliage should be particularly attractive to them for food.

Domestic animals of various kinds are also important factors in altering the natural vegetation by destroying certain species that they prefer. Goats and sheep are particularly destructive, in this

way, to shrubs and young trees. Goats have always been kept on the islands, but they were, in early times, very apt to die suddenly, apparently from eating poisonous plants, including tobacco, so that they have never been very numerous. The paucity of vegetation on some of the smaller islands, like Goat Island (or Charles Island) is probably due mainly to the pasturing of goats on them.

d.—Destructive Effects of Drouths.

There can be no doubt but that the unusually severe drouths that occasionally occur, even on continental lands, serve to destroy vast numbers of native plants that grow in the drier places, and in some cases those that live even in bogs and swamps, in case these become dried up. On islands of small extent, with a thin, dry, porous soil, drouths are still more disastrous, for there is no great reserve of moisture in the soil, and besides this, the less common plants are generally localized in but few limited spots, so that if these dry up the species is liable to become extinct. Probably this has repeatedly occurred at the Bermudas in the past, before their settlement, as well as since, and many plants that had established themselves there for many years may have been exterminated in a single exceptionally dry season.* This would affect chiefly the plants of the uplands; those of the bogs and seashores would suffer much less.

The cutting away of the forest trees, thus exposing the light thin soils to the blazing sun, undoubtedly increases the destructive effects of drouths to a very great extent.

* During a long and very severe summer drouth, which occurred at Bermuda in 1849, it is recorded that a large part of the cisterns and wells failed, all grass and other green herbage disappeared on the hills; the sage bushes lost their leaves; and even the cedars turned yellow. Many cattle died and numerous people were ill with intestinal diseases. (Hurdis.)

There was scarcely any rain from May 18th to July 31st. This same drouth extended over the northern United States and British America, and in Canada vast forest fires occurred, so that the dense smoke, like a fog, extended all the way from New York to Bermuda.

Undoubtedly many localized species of plants might easily be exterminated by a drouth like this, even in a much larger and more varied country than Bermuda, but our lists of plants living there before that time are too imperfect to determine how many disappeared then.

A prolonged winter drouth occurred in 1875, causing great damage to the crops and other vegetation. Many of the cisterns failed at that time. Copious rain came the last of March, otherwise there would soon have been very great losses. (Jones.)

26.—*Effects of Deforesting.*

The rapidity, extent, and injurious effects of the early deforesting of the islands can best be understood by reference to the early records of ordinances, laws, proclamations, and official letters, and from the contemporary narratives that have come down to us.

The shipwrecked company of the Sea Adventure first settled down near the eastern shore of St. George's Island, and built there the larger vessel of cedar. The greater part of the 150 persons lived there during most of their stay of nine months, including the whole of the winter. As they had only huts of palmetto leaves, they doubtless burned large quantities of cedar wood for fuel.

In fact, one writer speaks of the great fires that they kept continually burning, probably for signals. They also cut down, as Strachy says, thousands of palmettoes for their cabbage-like heads, on which they mainly depended for vegetable food. Therefore the eastern part of St. George's Island was the first place that was denuded of forest trees. Moreover, a large part of the early settlers, 1612 to 1620, remained in that vicinity and continued to cut the cedars and palmettoes in the same way.

In Governor Butler's "Historye," he mentions that in 1619 the Company assigned 400 acres of the "common lands," on these same hills of St. George's, for the support of the governor. But he says that even then the land here was of "no worth at all" for cultivation, and could be used only for pasturing cattle.

This shows how rapidly the forests had been destroyed here, during the first seven years of occupancy, and the marked decrease of fertility in the soil.

It will be most convenient to discuss in detail the causes, extent, and effects of the deforesting, under the three principal trees involved, because each one has a different history, peculiar to itself.

a.—The Bermuda Palmetto (*Sabal Blackburniana* Glazebrook); *its History.*

FIGURES 4, 32, 39, 40; AND PLATE LXIV; FIGURE 1. PLATE LXVIII; FIGURE 2

This very useful tree is one of the few plants that are peculiar to the Bermudas.*

* This palmetto is pretty fully illustrated by Mr. W. B. Hemsley in the voyage of the Challenger, Botany, i, p. 70, plates vi to ix, 1885. The swamp variety is also figured in the "Garden and Forest," vol. iv, July, 1891, pp. 302, 307.

Although much like the Palmetto of the southern United States, it differs in several important particulars. It grows larger; its fruit is larger, more abundant, succulent, and edible; it is blackish in color, and about as large as a large cherry. Sometimes the clusters of berries are four feet long, and contain a large number of berries.

Full grown palmettoes, even now, may become fifty feet high, with a spreading crown of leaves twenty-five to thirty feet across. The larger leaves may have a fan or blade eight feet or more long and nearly as wide, supported on a petiole or stem six to ten feet long. But most of those now growing are comparatively young, and mostly less than twenty feet high.

Figure 89.—Bermuda Palmetto, moonlight effect.

Governor Lefroy, in 1877 (Memorials, ii, p. 70, note), said that one then growing in the Pembroke Marsh was fifty-three feet high, with a clear trunk forty-seven feet high, to the lowest leaves.

When growing in good soil in open land the trunk is sometimes three to four feet in circumference, and usually not more than twenty to twenty-five feet high, to the leaves. In the marshes it grows taller and more slender, the circumference seldom being over twenty-four to thirty inches. In dry places the trunk is irregular, with larger and smaller portions, varying according to the degree of dryness of different summers. The rays of the fan-like leaves run out into long, slender, flexible, drooping tips, when fully mature.

In winter, most of the older leaves turn yellow and die, and they are often much damaged by the violent winds, especially when in exposed places, near the shore. It is of slow growth, like many other palms.

The early settlers all considered it an exceedingly valuable and useful tree. Admiral Somers' party and the early colonists used large quantities of the berries for food, in their season. The wild hogs fattened upon them, and so did the domesticated hogs that were very soon introduced there. Large numbers of the trees were cut down, at first, for the soft head or cabbage, which, like that of the Cabbage-Palm, is edible and nutritious when boiled.

A little later the natives learned to make an intoxicating liquor called "bibby" or "beeby," from the fermented sweet sap and pulp of the interior, and they cut down large numbers of the best trees for this purpose.

The leaves, in early times, and for more than sixty years later, were extensively used for thatching the roofs and the sides of dwellings, and of the first churches. At the present time they are still used for the manufacture of hats, fans, and baskets, and sometimes for braiding various fancy articles.

When the islands were first settled the Palmetto was very abundant, according to the earliest writers, and it seems that it grew to a much greater size than it does at present.

Cutting the trees down for their heads to cook, and for the sap to make "bibby," led to the destruction of most of the larger trees in less than thirty years.

In the narrative (1610) of William Strachy, who was one of Admiral Somers' shipwrecked party, the following account of the Palmetto appears: "Likewise there grow great store of Palme Trees"; . . . "in growth, fashion, leaves and branches, resembling those true Palmes; for the tree is high and straight, sappy and spongious, unfirm for any use, no branches but in the uppermost part thereof, and in the top grow leaves about the head of it, the most inmost part whereof they call Palmeto, and it is the heart and pith of the same Trunke, so white and thin, as it will peele off into fleaks as smooth and delicate as white Satin, into twentie folds (in which a man may write as in paper) where they spread and fall downward about the Tree like an overblown Rose, or Saffron flower not early gathered." . . . "With these leaves we thatched our Cabbins, and roasting the Palmito, or soft top thereof, they had a taste like fried melons, and being sod they eate like Cabbedges, but

no so offensively thankfull to the stomacke. Many an ancient Burger was therefore heaved at, and fell not for his place, but for his head." . . . "They beare a kind of berry, blacke and rounde, as bigge as a Damson, which about December were ripe and lucious; being scalded (whilest they are greene) they eate like Bullases" [bullaces].

Silvanus Jourdan, another of Admiral Somers' company, gave the following account:—"And there is a tree called a Palmito tree, which hath a very sweet berry, upon which the [wild] hogs doe most feede; but our men finding the sweetnesse of them, did willingly share with the hogs for them, they being very pleasant and wholesome, which made them carelesse almost of any bread with their meate; which occasioned us to carry in a manner all that store of flower and meale wee did or could save for Virginia. The head of the Palmito tree is verie good meate, either rawe or sodden, it yeeldeth a heade which weigheth about twentie pound, and is far better meate than any cabbidge."

His statement is important, as explaining how it happened that with only the limited amount of meal saved from the wreck, they were still, at the end of nine months, able to carry a supply to the starving Virginia colonists.

Admiral Somers stated, in his Virginia letter of 1610, that the allowance of meal in Bermuda was not above a pound and a half a week for each man, during the nine months, and the same allowance was continued to the Virginia colony, after his arrival there.

Governor Moore, who had recently arrived on the "Plough," with the 60 original colonists, in 1612, gave an account of the islands and their natural productions which was very good indeed, considering that he had been there only about forty days, as he remarked incidentally. This letter seems to have been sent back on the return voyage of the "Plough," and from internal evidence, was written by Governor Moore, himself. (See p. 547.) He says:—"And for the Palmito tree, the top of it is a great deale sweeter and wholesomer than any cabedge." . . . "The top of the Palmito tree is in season and good all the yeare." . . . "I must needs mention the Palme tree once againe, I have found it so goode; take a hatchet and cut him, or an augur and bore him, and it yeelds a very pleasant liquor, much like unto your sweete wine; it bears likewise a berry in bignes of a prune and in taste much like."

The "pleasant liquor" here referred to was the "bibby," which later proved to be a great curse to the colony, as an intoxicant. A

little later, the people were not content with tapping the trees for the sap, but cut down the largest ones to extract the entire pulp and juice from the interior to make this drink, which was at first used only as a fermented beverage. It was, however, decidedly intoxicating and led to much drunkenness and disorder.

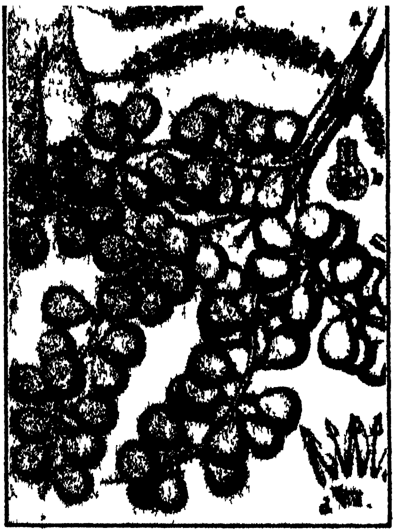

Figure 40 —Palmetto. *a*, berries, part of a cluster, *b*, section, *c*, male flowers, *d*, parts of a male flower; *e*, a stamen After Hemsley

In 1627, a law was passed prohibiting the cutting of the palmettoes for this manufacture, except by due warrant. But like most modern laws against intemperance, this law was not altogether efficient, for later the natives even learned how to distill it and make an "aqua-vitae," which was a bad kind of strong rum or "vino." Complaints were made at that time that the tallest and best palmettoes were being rapidly and recklessly destroyed for this use. Another more stringent law was passed in 1652 against cutting the trees for this purpose, and others in 1662, 1666, and 1668. This liquor is said to have made men wildly, madly, and dangerously drunk.

In October, 1662, the Bermuda Company ordered the palmettoes to be preserved on the small islands so as to afford leaves for thatching the houses, as follows: "Ffor preventing the great mischiefe that is like to ensue to the plantacon for want of thatch by reason of felling of Palmetto Treese in the little Islands, wee have ordered

that all the Palmetto trees be henceforth preserved, and that you the Governor & Councell take care and give comand for planting of them in all the little Islands."

In 1671, another law was passed against persons destroying the palmettoes "on the small islands" and thus depriving the inhabitants of the means of obtaining the leaves for thatching their houses.

At the present time, numbers of young palmettoes may be seen coming up, here and there, all over the wooded parts of the larger islands, and if protected they may, after many years, become large trees, if in good soil, but when the soil is thin and barren they never become tall, but grow in the form of a dwarf palmetto, with a trunk only a few feet high, or sometimes even without any trunk above ground.

In 1675, it was ordered that some houses thatched with palmetto leaves and standing close to the town hall should be shingled to diminish the risk from fire. Shortly after this the Company urged the general use of shingles for roofing in St. George's.

On July 18, 1677, an order is recorded in the Parish Register for thatching the Pembroke church with palmetto leaves, each person to bring in "eight dozen good leaves" on the 25th of July, or else pay $1^{sh}\ 4^{d}$, and this order was made a permanent one for the future, whenever the church should need thatching.

Governor Butler, in commenting upon the destitution and famine in the time of Governor Moore (1614), makes the following remarks:

"The overcleareing of St. George's Iland, which was the place of their residence, by cuttinge downe the palmitoe trees, to have their heades for foode, a cheife releife of the people at that time, but such a disableinge of the place for tobacco (which is as yet the staple commoditie), as that not only to this day but for many yeares to come it must needes to feele the weight of that stroke; neither was it possible for the governour to cure or prevent this ill, by any prohibition, because the belly hath noe eares."

Although Governor Butler here refers only to the palmetto, it is certain that the cedars had been cut down quite as extensively, if not more so, for timber and wood, during the same years, and the effect of cutting down the cedars would have been the greater, for it makes the better wind-break, though when young the palmetto is also pretty effectual, and it was often mentioned as being used for division fences or hedges. The removal of the shade from those hills, that are naturally dry, would have increased the dryness in time of drouth, and this was also a cause of increasing barrenness.

b.—*The Bermuda Cedar* (*Juniperus Bermudiana* Linné); *its History.*

FIGURE 41. PLATE LXVIII, FIGURE 2 PLATE LXXIII.

When the Bermudas were first visited by Europeans, all the islands that had any soil upon them, including most of the smaller islets, were thickly covered with the cedar. Even to this day, much of the beauty of the landscape depends upon the cedars that still densely clothe many of the small islands, adding much to their

Figure 41.—Bermuda Cedar: *a*, branchlet with young berries, *b*, with larger berries; *c*, a branchlet with male flowers; *d*, a berry slightly enlarged. After Hemsley.

apparent height and size, and contrasting, by their dark green, graceful foliage, with the surrounding rocks and water. After these small islands are stripped of their cedars, they at once look rough, rocky, and barren.

The poet, Thomas Moore, when he wrote at these islands, in 1804, well appreciated this effect of the cedars on the landscape, and especially of those that crowned the small islets in St. George's harbor. (See p. 446.)

This cedar is by far the most abundant and most important of the native trees of the Bermudas. It is almost restricted to these islands, and until recently was not known from any other locality, for it is

distinct from the Barbadoes Juniper, or Cedar, with which it was formerly confounded by most writers.*

In general appearance it resembles the American Red Cedar. It grows more rapidly and to larger size, and its wood is very much harder and heavier, and not so red. The foliage is lighter and more bluish or grayish than that of Red Cedar. Its berries are more pulpy, with smaller seeds, and are edible. At least they were eaten by the early settlers, in times of scarcity, and are still often eaten by children.

They were also valuable, like the palmetto berries, as the natural food of the wild hogs, found on the islands by the first settlers, and also for the domesticated swine that were immediately introduced They ripened in the fall and, according to Strachy, were all gone early in December, two months before the last of the palmetto berries.

The early settlers also learned to make a liquor of them, by steeping them in water and allowing the decoction to ferment for a few days. The quality of it is not fully described, but many of the early colonists were desperately fond of anything that would intoxicate them The gum of the cedar was also used medicinally.

The timber was used for building the small vessels in which Henry May and his shipwrecked companions escaped to Newfoundland in 1604, and also for building the two larger vessels in which Sir George Somers and his company of one hundred and fifty shipwrecked people sailed to Virginia in 1610, though some oak from their wrecked vessel was used for the timbers and some of the planks in the larger of their two vessels. The timber is very durable. Boats built of it have been kept serviceable one hundred years, it is claimed.

The early settlers used the cedar wood extensively for all building purposes, including boats and larger vessels, as well as dwellings, and also for fuel and for the shipping boxes or "chests."

In the early years the timber was shipped to England, when full cargoes of tobacco, or other commodities, could not be had for the return voyages of the "magazine ships" sent out by the Bermuda Company. The cedar was highly valued at that time in England for the manufacture of choice furniture, for mahogany and rosewood were then practically unknown.

Instructions from the company to the governor to cut down and

* About 1885 it was found growing, in a limited district, in the Blue Mountains of Jamaica (See Voyage Challenger, Botany, vol 1, p 82.)

hew "the best and straightest of the cedars in David's Island," were given in 1615, when other freight was not available. In 1616 the shipment of a cargo entirely of cedar is recorded.

Much cedar timber was also destroyed in Governor Tucker's time, about 1616 to 1618, by burning over large tracts and entire small islands to kill the Wood Rats, which were then a great pest.*

Governor Butler (1619) speaks of Governor Tucker as "often fireinge of the whole ilands to the huge wast and spoyle of much excellent cedar timber." And yet he says that the rats, in spite of this and all other efforts, "every day multiplied and grew." He had even "determined once againe to fall upon another generall burneinge of the whole ilands, to the extreame discontent of all men, and especially of Mr. Lewes, the minister, who openly preached against it, so that the governor could never endure him afterwards."

Fortunately for the inhabitants, the rats all suddenly died just at that time (in the winter of 1618–19), probably of starvation or a pestilence, so that the remaining cedars were saved from burning. Governor Butler's statement indicates, however, that there had been one general burning. In another place he states that the governor and his men had burned over one of the Brothers Islands, and found it full of rats, and therefore ordered the other burned, but it was not done. The name "Burnt Point," early applied to the western end of St. George's Island, may refer to one of these burnings, for it was thus named on Norwood's map of 1622. The islands were perhaps overpopulated, even before 1630, by inferior classes of laborers, taken from the slums of London and continually sent out by the Bermuda Company. Many of these persons were lazy and shiftless, and according to Governor Butler, some women were taken from Bridewell and some men from the Newgate Prison,† and others were impressed. The good soil is very limited in extent to support any considerable number of people by agriculture alone. It was thus nearly impossible to immediately build fortifications and other works, as the Company required, and to clear the land and raise so much tobacco as was demanded by the Company, and at the same time raise enough corn and other food-stuffs for the inhabitants, even in the best seasons. Many times there was great scarcity of food, or even famine in the winters. Therefore, nearly all the best arable land must have been rapidly cleared of trees in the early years.

* This plague of rats will be discussed in a later chapter. (See ch. 33, *b*)

† This probably accounts for an early law, forbidding any one referring to the previous bad life of any colonist before leaving England.

In 1622 an order (No. 207) was made by the Company requiring the annual storage of a large amount of corn, as a public magazine, to be used only in times of scarcity, each person to contribute his share.

But the rapid cutting and burning of the cedars soon began to alarm the more intelligent governors and planters, because of the growing scarcity of good timber, and also because the lack of its shelter from the blighting salt winds soon began to be felt, as injurious to the plantations. Governor Butler, in particular, seems to have been impressed with this injurious result. Consequently stringent laws were soon passed restricting the cutting of cedar and forbidding its exportation without special warrant. At first "chests" or boxes of cedar were much used for the exportation of tobacco and various other commodities, but in 1632 a law was passed prohibiting the exportation of "cedar chests," whether full or empty, without special permission. Probably the lumber of the chests brought a good price in London, at that time, for furniture. These chests were made very large and of thick lumber. Finally a rule was adopted by the Company that the captain of the magazine ships should not receive chests of tobacco weighing over 1500 pounds. The price for sawing the cedar timber into planks, which had to be done by hand, was usually 2^s 6^d per foot, in Bermuda, therefore the thicker the lumber was made for chests the greater the profit.

In 1622 the Bermuda Company enacted a series of two hundred and twelve "Orders and Constitutions," "for the better governing of the actions and affaires of the said Company and Plantation" of the Summer Islands. These mostly remained in force for at least fifty years, with few changes. No. 115 contains the following restrictions on cutting timber :—"they shall also have especial care of the preservation of timber that no waste be made thereof. And in particular that no man presume without the owner's consent under his hand and seals, to cut down young Cedar trees, before they be come to their growth, under a grievous penalty to be assessed at the descretion of the said Governour and Councell. Neither shall they suffer any Timber, Boards or Plankes to be transported out of the said Ilands, without especiall warrant from the Governour and Company here."

No. 116 reads as follows :—"Care also shall bee taken that all sorts of trees, which defend the Ilands from Winds and Tempests, bee preserved and maintained; where decay hath been that young Plants be there set and cherished."

This ordinance shows that at this time the value of the cedar and other trees as wind-breaks had begun to be understood, through costly experience, and probably largely through the representations of Governor Butler, who had just returned to London.

At that time the tamarisk, oleander, and other resistant trees had not been introduced there. It is uncertain whether the "seaside grape" was native there or introduced later. The cedar and palmetto were certainly at that time their main reliance for this purpose, near the shores, and also for the division fences or hedges

In 1632 the governor issued a proclamation against the cutting, selling, or exportation of cedar and yellow-wood timber in any form, without special warrant. The penalty for each offense was a fine of fifty pounds of tobacco, and imprisonment "at the governor's pleasure." (See p. 609.)

Such stringent prohibitions naturally did not have a tendency to cause the planters to plant or preserve young cedars, for they could not be sure of having any right to use such timber as they did save.

In 1659 a law was passed allowing chests "filled with the commodities of the islands" to be exported, but prohibiting the exportation otherwise, or the building of cedar vessels to be sold away from the islands, without special warrant.

The following is a part of a proclamation issued March 3, 1659, by Governor Wm. Sayle, in regard to the destruction of the cedars:—

"To the inhabitants of the eight Tribes and the Publick Lands. I have received from the Honorable Company a command not to suffer any Timber to be transported out of the Islands I have prohibited all men from transporting any Timber either for England or any other place ; and I, seeing the great want of Timber in the Islands, have thought it my duty to stir up all the Inhabitants of this Island to take it into consideration what a miserable state this Island will be brought into in a short time, if a speedy course be not taken, for half the land in the Island hath not wood to serve for fuel, and yet I do perceive that few, or none looketh after their own good or after generations to come. I now see to the great grief of my heart such abundance of Cedar burnt by firing ground even to the destruction of the Country, which if men had public spirits they would not dare to do, but by their acting they seem to me as if they did desire the destruction of the land ; for if those Cedars which are daily burned and destroyed through the carelessness of their servants, or their own carelessness, not regarding the good of the land, they do daily burn and destroy abundance of firewood that might, with little labor,

be saved for their own benefit, and the benefit of them that shall spring up after them, as all good commonwealths men would do, and whereas many do pretend by their lopping off young cedars to preserve them, they by their negligence, or to save them the labor to carry away the bush, they fire it so near the trees, that they do burn up the cedars that might by the blessing of God be fit for any use, which the Inhabitants will in a short time stand in need of, even to the destruction of the land, if not timely prevented. These are therefore for to will and require every person and persons in the land to use their uttermost endeavors for the preservation of all young cedars, and to be every year a planting of young cedars for the fencing of their grounds, so by that means the fruits of the earth may be preserved from blasting; and as the old timber doth decay, the young trees may grow up for the use of the land, that the land may not be deserted, for without timber we cannot subsist. Therefore, whosoever for the future, shall be found guilty in any of the premises, they must expect no favour, but to receive condign punishment according to their several demerits. These are desiring all to take notice hereof whom it may concern, as they will answer the contrary at their uttermost perils."

The following are among the General Orders of the Company to Governor Fflorentia Seymer [Seymour], when he was appointed in October, 1662:—

"In the first place. To prevent the destruction of Timber in the Islands and the want that is like to ensue thereuppon, wee have ordered as followeth,

(1) That no Tenent shall fell any Tree but for necessary repayres.

(2) That no Timber be felled as aforesaid in any of the Tribes for necessary repayres but what shall be allowed by the Councellr of the same Tribe before it be fallen.

(3) That the stealing of Timber be provided against by a severe punishment of the offender.

(4) That at cleering of ground no tree shall be lopped but at seven foot height and in seasonable time and that no brush wood be burnt upon the place where any Treese do grow and are fallen, but be used as fewell by the respective Tenents in their houses.

(5) That every owner and occupier of land do maintaine his fences according to the law in that behalf and that in the fences in an husbandlike maner, they plant Cedar, Olive, Lime, Pomegranate, Fig, Orange Trees, which will sufficiently supply the want of Timber and make the place fitter for growth and defensable against windes that otherwise proove soe destructive in the place."

In 1671, the Company complained that three vessels, not belonging to them, had been allowed to take away cargoes of oranges, packed in some hundreds of boxes made from young cedars, and therefore made an order that no one should cut cedars less than 8 inches in diameter, or else forfeit 40 shillings for every tree so felled. All persons were also forbidden, at the same time, to consign any boxes or casks made of cedar to any person not a member of the Company, or to "colour" any such boxes of cedar.

The condition of the cedars on the islands about 1660–70 may be understood from the following documents. The first is part of a remonstrance sent by the Council to the Bermuda Company against an anticipated law (adopted subsequently) prohibiting the building of any vessels of more than five tons.* After giving weighty arguments for the benefits to be derived from building vessels, the remonstrants say as follows: "But it may be objected:

ffirst. The Plantacon is bare of Timber and some Planters want wood to burne

2ndly. If shipping should be built they would have neither timber nor plantes for fortification. To the first wee answer that covetiousnes was the first cause of the desert, by ther sale when time served, or burning to make roome for Tobacco &c. and the remedy for this disease did much more increase it (videlzt), the Prohibition, ffor who would be soe weake to plante and preserve that which will yield noe present profitt neither could enjoy that to dispose of, the which, instead of pservation hath caused the destruction of abundance of young Cedars and of much good timber, beside the great number of good old treese blown downe by winds, which perish and lie rotting on the ground in many places, soo that of Treese of great bigness can scarce be gotten sixe inches of Coopers Timber. Moreover our late Governr hath given good example, if followed wee need not feare want of firewood, or of Timber to build with, ffor in Twentie yeares a plant well preserved may be good building timber."

In 1668, the Bermuda Company enacted the law, referred to in the previous remonstrance, forbidding the building of vessels larger than five tons at the Bermudas. But perhaps this was more for the purpose of preventing trade with the other colonies than to save the cedars, as pretended. At least that seems to have been the way it was viewed by the Bermudians, and it was in accord with the general policy of the Company. This law was enforced, so far as

* This law continued in effect till the dissolution of the Company in 1684, but was not strictly enforced.

possible, down to 1684, when the charter of the Company was withdrawn.

The following record indicates the value of the cedar wood in England, for furniture, and the stringent rules against shipping it :*

"At a General Court for the Somer Islands Company held in Watling Street, London, on Friday the 27th April, 1667." "Mr. Henry Moore a member of the Company, having been an Inhabitant in the Islands for 30 years past, and having purchased several shares of Land there, some whereof are well timbered, and having thereon many cedar trees fallen and upon spoil And never having transported for his own or his friends use, any Cedar in all his time, craves liberty to transport three Ton of such cedar trees only, to pleasure friends for kindness received, which is granted."

In 1675, the Company enacted another law forbidding the use of cedar in any form, as fuel for boiling the juice of the sugar cane to make sugar. This industry was never carried on here except in a very small way for local consumption. But much cedar fuel has always been used in the kilns for burning lime.

In spite of all these restrictions, the cedar forests continued to be rapidly destroyed, as they must needs be in a place of limited area, where there was very little other fuel, or other available timber for building, so that before 1700 many of the land owners had no trees, even for domestic fuel, on their land.

Moreover, the Bermuda Company were continually demanding the planting of more and more land with tobacco and other crops that could furnish profits to them, and the forests of cedar had to be cleared away to make room for the fields. In many cases the planters were accused of killing the young cedars in burning the brush. Doubtless this was often done recklessly and without due reference to its ultimate effects in rendering the land unproductive in exposed situations. But the roots of the cedars extend very far in all directions in search of good soil, and no cultivated crops can be grown very near them on this account, for they rob the soil. All the cedars now on the islands are "second growth" and "third growth." The small forests and groves are mostly situated on the hills, where the soil is thin and not arable. Originally the cedars also grew in the lowlands and swamps, where they attained a larger

* Doubtless it was on account of the value of the cedar lumber that the "chests" were gradually increased in size till the captains of the ships complained of their great weight. In 1679, a rule was adopted that none should be shipped weighing over 1,500 pounds.

size. In the letters of Governor Roger Wood, about 1633, he stated that he had sent to his English friends cedar planks 30 and 32 inches wide and 12 to 13 feet long. These were sawed by hand, and indicate trees much larger than any now existing. Logs of cedar, five feet in diameter, are sometimes found, it is said, in the peat-bogs of the islands. One of the oldest cedars on the islands stands in the churchyard, by the side of the old abandoned Devonshire church. It is about five feet in diameter and much decayed.* Only two others as large are known. Some of the largest and finest trees on the islands are known to be about 200 years old. Those by Pembroke churchyard were set out in 1717.†

Several fine cedars standing in a group near the new Devonshire church were preserved from destruction some thirty-five years ago by the Hon. J. H. Darrel, who bought the land and presented it to the parish, with the stipulation that these cedars should never be cut down. He deserves to be held in perpetual memory for this wise and generous act. Many other fine cedars also grow in that vicinity.

Many of the finest cedars along the roadsides and in private grounds are not over forty to sixty years old. I was shown many tall ones, now from ten to twelve or more inches in diameter, that were planted only about forty years ago by the present proprietors, showing the rapidity of their growth in good soil. Indeed, it is said that they sometimes make good sized trees in twenty years.

For more than half a century past, and up to the present time, the cedars do not seem to have decreased in number. They may, indeed, have increased considerably within the past fifty or sixty years. This is due partly to the greater care taken to preserve them in many places, especially on government lands, and to the replanting of them in some places, but probably, in a greater degree, to the

* This tree is well figured in the "Garden and Forest," vol. iv, p. 294, 1891. A specimen of a large cedar growing in a marsh is also figured on p. 295. The old Devonshire cedar is also figured in Stark's Bermuda Guide, p. 122, 1897. Its age is unknown.

† The following record appears in the Register of the Pembroke Parish: "Be it Remembered yt upon th 24 day of Oct. 1717 the double row of cedars was planted round the Church in Pembroke Tribe all within the bounds of the church yard, and the 7th of November following the rafters were raised upon the new church."

Many of these trees are said to be still standing, and are of larger size than most of the cedars now living. When very old the cedars are often decayed at the heart. The earliest settlers complained of the inconvenience of this in ship building.

much greater facility with which lumber and fuel can now be obtained from the United States and Canada, than formerly.

At present, nearly all the lumber used on the islands is shipped from American ports, including the very large amount used for the crates in which the onion crop is shipped.

The decrease in the cedar timber was one of the causes that led gradually to the use of stone for the construction of nearly all the dwellings, and even for the barns and outhouses.

Probably the violence of the occasional hurricanes was another important cause that led to the use of more substantial buildings. Moreover, the abundance and cheapness of the limestone, and the ease with which it can be worked, by sawing it into square blocks with ordinary saws, were also very favorable factors in the change from wood to stone dwellings. Governor Butler, in 1620, erected the first stone public building for the "Town House," at St. George's, as an example, as he said, for the people to follow, and thus save the cedar trees, but very few other stone houses were built for at least eighty years later.

The Company had ordered a stone house to be built on Long Bird Island, in 1625, but as Governor Woodhouse objected to it, he was permitted by a letter of March, 1626, to build it of cedar at his discretion.

In 1676 the English government requested information on the conditions of the Bermuda colony, asking a series of questions. The official replies from the Bermuda Company, in 1679, contain much information. Among other things it was stated that the houses were nearly all of cedar at that time. The names of the forts then in use were also given, with the number of guns. Among them were King's Castle and Southampton Fort.

From 1700 to 1810 shipbuilding and commerce were carried on to a considerable extent by the Bermudians,* agriculture having fallen into disrepute, owing largely to the social effects of slavery, it is said, but the lack of a good market was also a great drawback. Cedar was almost exclusively used for the shipbuilding, but it must have been obtained chiefly from the young forests that had grown on the neglected farm lands of the previous century.

* Their commerce was interrupted from 1798 to 1799, by the French privateers, and again in 1812-14 by American privateers. After 1828 they had to compete with American vessels in the West Indian trade, and their commerce declined again.

The Yellow-wood (Xanthoxylum aromaticum); its History.

The early historians often refer to a large and valuable timber tree that they called Yellow-wood.* Its wood was fine-grained, very yellow, and had an aromatic odor. The bark had a pungent taste.

The earliest and best account of this tree was written in 1612 by the anonymous writer, believed to be Governor Moore. After describing the cedar, he says:

"The other sorte we have no name for," . . . "some did think it to be Lignum vitae; but it is not so; it is a verie fine wood, of colour yellow, and it bears a leaf like unto a walnut tree, and the rine [rind] or barke is much like a walnut tree, and the barke, if one taste of it will bite one's tongue, as if it were Ginney Pepper, that wood is also very sweet."

The Bermuda Company, in their commission to Governor Moore (1612), mentioned the Yellow-wood as an unknown timber, of which they wished him to ship a "tunn" for examination.

This tree seems to have been common and generally distributed over the larger islands at the time of the early settlements, but was never abundant. It is spoken of as used for lumber, and it was also early exported to England, for several laws were passed and proclamations issued against exporting it, without permission.

That Yellow-wood timber continued to be an article of illicit traffic appears certain from a proclamation issued by Governor Roger Wood, Oct. 6, 1632, of which the following is an extract:

"As also the like punishment shall be inflicted upon every such p'son or p'sons as at any time hereafter shall be approved to have conveyed aboard any shipp or barque that shall arrive here (not having a sufficient warrant for the same) either trees, juncks ceader or *yellow wood*, boards, clefts, chests, plankes or the like, contrarie to the true intent and meaning of this my proclamacon And lastlie I doe hereby ordaine and confirme for a law, by and with the consent of the whole Counsell, that what seaman soever that shall hereafter arrive here, be he Captain or master or other officer or comon sayler that shall receave and take aboard any ceader or *yellow wood trees*,

* At present, the name "Yellow-wood" is applied locally to two very different trees of the genus *Erythrina*, which are not aromatic nor pungent. They belong to the Leguminosæ, and are similar to the Locust-trees. One of these seems to have been introduced in rather early times; the other, about seventy-five or eighty years ago.

juncks, clefts, timber, boards, chests or plancks more than what they have sufficient order for, shall for every offence in this nature, forfeite and pay the some of 50 lbs of tobaco or the full value thereof in good commodities, out of every w'ch such forfeiture, the Informer of the same shall for his paines and fidelity receave 20 lbs."

Probably it was highly prized in England as a cabinet wood, in those days, on account of its hardness, fine grain, and peculiar color, and the high price of the wood led to the illicit shipping of it, as in the case of the cedar.

Governor Lefroy, who identified this tree as above named, stated that only one tree was then (1876) known to exist on the islands. That one was in the Walsingham region, on a hill east of Paynter's Vale, and was about ten inches in diameter. Whether it still exists I do not know.

He stated that he also found a few seedlings in the same locality, but did not succeed in his efforts to transplant them, owing to the very long tap-root, nor did he ever find the tree in flower or fruit. He supposed that this was the only survivor of the tree in Bermuda.

So rare a tree should have been carefully protected and saved from extinction. But it is evident, from the several Governors' proclamations and the early laws passed, that some effort was made to preserve it. It is a native of the West Indies.

This true Yellow-wood tree, which has aromatic, pinnate leaves, belongs to the Rue family (Rutaceæ), and is related to our Prickly Ash.

The Yellow-wood Tree and the Legends of Buried Treasures.

In 1690 a royal charter was granted to Thomas Neale, for the recovering of treasures which, according to traditions, had been buried on Ireland Island and Cooper's Island by the crews of shipwrecked Spanish vessels, before the Bermudas were settled. In connection with this project, a number of interesting and curious depositions were taken, in 1693, from several of the aged inhabitants, who had, many years before, seen the signs alleged to have been erected to indicate the spots where the treasures were buried. Some of them stated that about fifty years before they had themselves engaged in searching for the treasures. Most of the depositions referred to Ireland Island, where it was said a large amount of gold coin had been buried under the sand and beneath the ship's hatches.

In nearly all of the depositions, relating to both localities, a Yellow-wood tree is said to have been found with an inscribed brass

plate and a cross nailed to it. It is a great pity that these tablets were not preserved. Probably the inscriptions were in Latin or Spanish, or both, which could not then be translated by the finders. They might have given valuable information as to the early discovery of the islands and of unrecorded shipwrecks there. As the marks and tablets were described as nearly identical at both ends of the islands, they were probably placed by the same party. Had they been attached to the trees when the islands were first discovered, over a hundred years earlier, they would have been overgrown by the wood or destroyed by the weather, for the saltness of the air would soon corrode brass so as to render the inscriptions illegible. Very likely they had been placed on the trees not long before 1600.

That such marked Yellow-wood trees did actually exist there, up to about 1630 or 1640, cannot be doubted, from the abundant testimony of the witnesses.

Some of the depositions were made by men prominent in the colony, including Richard Stafford, ex-chief judge; William Keeling and William Seymour, justices of the peace; Capt. Jonathan Stoakes, and several others.

The inscribed brass tablets on the trees were, however, more likely to have been memorial tablets, recounting the adventures of the party and claiming the ownership of the islands by right of discovery. Such notices were commonly erected on newly discovered islands in those days. Possibly these tablets were left by the Spanish crew of the Bonaventura, wrecked with Henry May, in 1693, or by a French crew, known to have been wrecked there a number of years earlier. But there were, no doubt, many other Bermuda wrecks, not recorded in history.

Governor Gates, when his party left Bermuda in 1610, caused a similar engraved memorial tablet, made of copper, to be nailed to a "mightie cedar" at St. George's, with a cross, and the effigy of the king of England, in the shape of a coin. This tablet gave the main facts of the shipwreck and escape, with the dates and the names of the commanders. It was inscribed both in English and in Latin, and the cross was made of some of the oak timber of the ship. (See p. 542.)

For our immediate purpose, these depositions are of interest as showing that at about 1650 large Yellow-wood trees grew both on Ireland Island and Cooper's Island. Moreover, the great density of the wood is shown by the testimony. Two of the deponents stated that the marked large Yellow-wood tree on Cooper's Island was cut

down by a Captain Seymour, about 1640. This was done, according to Joseph Wing of Cooper's Island, for the purpose of shipping the trunk, with its tablet attached, to the London Company, and probably by their orders. But in towing the trunk out to the ship, behind a boat, the rope broke and it went to the bottom, from whence it could not be raised without more trouble and expense than was thought warranted. They stated, also, that this tree trunk could be seen upon the bottom for many years afterwards. These depositions confirm Governor Moore's statement, in 1612, that the wood was very hard and heavy, and had been mistaken for *lignum-vitæ*.

In several of the depositions it was stated that a cross had been found in the early days nailed to a tree trunk on Cross Island, a small island close to the east side of Ireland Island.* This island was named Cross Island on Norwood's map of 1663, but it was named Sober Island on the Admiralty chart, and it is now called Magazine Island. The cross stood with one of its arms pointing to Spanish Point and the other to the marked Yellow-wood tree on Ireland Island, where they also found three stone monuments, enclosing a triangular space, supposed by them to indicate the spot where the gold was buried, according to several depositions.

But the natives were so superstitious at that time, and so afraid of the ghosts and demons that were supposed to guard ill-gotten Spanish treasures, that no careful search seems to have been made, nor is there any record of treasures recovered there, except a few small lots of coin and some silver spoons.

This cross, the stone monuments, and labelled trees were believed to confirm a tradition of buried treasures, said to have been derived from two different persons, who had been told by old Spanish sailors, in foreign ports, that they had belonged to the shipwrecked crew of the Spanish vessel and had helped to bury the treasure under the vessel's hatches, and to erect the cross and signs by which to find it again. According to one of these accounts, the vessel was that of one Juan Bermudez, but not necessarily that of the one who discovered the islands, for the name was a very common one in Spain at that time, like John Smith in England.

* As this cross was of wood and in a very exposed place, it is not probable that it could have been put there many years before the settlement; otherwise it would have decayed. One of the deponents stated that he had seen the tree trunk to which it was fastened, still standing, about 1650.

In the depositions, the Rev. Sampson Bond,* a clergyman who arrived in Bermuda in 1663, and lived there up to 1689, or later, was said to have been one of the persons to whom these Spanish stories had been told, while he was a prisoner of war at Groine. According to the tradition, the shipwrecked crew, after burying their treasure, built a vessel of cedar at Spanish Point, in which they escaped. But the traditions do not suggest any reasons why they should not have taken their treasures with them, if they had any to take. Whether the name of "Spanish Point" was derived from this tradition I do not know, but it is not unlikely. This name appeared on Norwood's map of 1622 Cross Island was evidently thus named from the cross found there.

Possibly such treasures may have been buried temporarily by the officers for safe keeping, while the vessel was building, and then carried away, though it might have been purposely left by dishonest officers who hoped to return for it later, on their own account.

As Ireland Island† was pretty much all dug up and its surface entirely altered many years ago, in building the navy yard and other public works there, buried treasures, if any existed at that time, might have been found by those engaged in that work. If so, there is no record of it, so far as appears. On the other hand, low places were filled up to level the land, so that anything buried in hollows would not have been found. Had treasures been buried, as imagined, it does not follow that one of the arms of the cross would point to the spot, nor that it would have been put in a marked triangle. That would have been too simple a device for the cunning Spaniards to use. Such marks might have been intended only for the identification of the particular Yellow-wood tree, selected as a landmark, for some special purpose, in case the tree itself should be destroyed, or not be easily distinguishable from others.‡

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* The Rev. Sampson Bond was banished from Bermuda in 1670, but was reinstated by the London Company and allowed to return in 1672. The vessel in which he took passage seems to have been the one captured by the Dutch, when the prisoners were taken to "Groine," a Spanish town. He arrived in Bermuda, via New England, in 1674. He was preaching in 1689, and perhaps later.

† I have found no historical reason for the name of Ireland Island. It may perhaps have been so called from its green verdure, and its position, across the channel from the early settlement at Spanish Point and that vicinity. It was sometimes called Long Point, in early times. It could not well have been named from its inhabitants, because Irishmen were generally banished at once from the islands, by the early settlers.

‡ The locality of buried treasures, for instance, might have been privately recorded by means of a line laid out by compass, running a certain number of

The old depositions are interesting as showing the superstitions still held at that time, even by intelligent and more or less educated men.

Some of the deponents, including ex-Judge Stafford, swore that "Fire-drakes" had been seen to fly over that portion of Ireland Island where the treasure was buried. Mr. John Hurt swore that he had himself sundry times seen the "Fire-drakes rise out of the said place or ground and assend the airo towards Ireland, by which scimtomes or marks this deponent supposes a great shipp or Spaniard to be cast away or lost right off from this Cooper's Island." The fire-drakes (fire-dragons) that they referred to were probably shooting stars or meteorites, for that was a common designation of the latter, at that time.

Others testified that "astrologers" (clairvoyants as they would now be called) and dealers in the "dark arts" had been there from New England and other countries to look for the treasure. Ex-Judge Stafford swore that when a young man he had been induced to go, with several others, in company with a mysterious foreign treasure finder, to look for the buried treasure, and that the said searcher showed them a curious white stone by means of which he expected to find the gold, and said he had found treasures in New England by its use. But Governor Haydon (1669–1680) heard of their trip and ordered them to return, for he and his council deemed it unlawful "to find treasures in that way." He probably considered it practicing the "dark arts." It must be remembered that at about that time and for some years previously (1652–1672) there were many prosecutions for witchcraft on the islands, and that at least four women and one man were executed for that crime by burning or hanging, and that the ordeal by water and the pricking of moles were regularly used at that time to detect witches.

One deponent swore that he and others had seen the apparition of ghostly ships sailing swiftly about Cross Island, without wind (like

yards or paces, in some definite direction from such a marked tree. The captain alone may have known the exact distance and direction. In such a case, amid luxuriant vegetation, it would be hard for any one else to find the spot, without these data, especially a few years later, even by a vigorous and prolonged search, which we have no reason to think ever took place.

But the selection and marking of these particular trees may have been for other purposes, quite apart from burying treasures. Still it is not impossible that valuables were actually buried in their vicinity and never yet found. The location of this particular marked Yellow-wood tree on Ireland Island was probably near the present site of the market.

the Flying Dutchman), where no real ships could sail for the shallowness of the water.

Others swore that when they tried to go to Ireland Island in boats to look for treasure they always encountered adverse winds and squalls, so that they could not land. Even the half-wild hogs were accused of being in league with the demons to drive intruders away. One testified that when he tried to dig there he was "possest with a panick ffeare, unwilling to make any ffurther prograce in serching or digging." This was very likely the case with others who were less frank in their testimony.

One party were convinced that they would be struck blind, temporarily, in case they should find the treasure, and so quit digging, saying "they would not trust the Devil with their eyesight," even temporarily.

Some of these deponents also repeated the tradition that the two Spanish ships that were attacked and driven off from Castle Island by Governor Moore, in 1612, had come here to find and take away the buried treasures.

Governer Butler, himself, in 1619, alluded to these legends of buried treasures, and to these ships as possibly coming to seek it, but he said there had been "divers greedy searches" for it even before then.

He, however, thought that there was evidence that Spaniards had been here: "Witnesse certaine crosses left erected upon rocks and promontories.* Some peeces of their coyne found scattered under trees, and the like signs of their being here. Upon which grounds, joyned with some intelligences (as they saye) out of Spayne itselfe, a report hath bin raysed of a great treasure, that should be hidd therabouts, which hath caused divers greedy searches; which all of them hitherto have proved vaine and effect-lesse."

Some of the depositions of 1693, which are of certain historical value, are as follows:—

"*The Deposition of Mr. John Keeling of Somerset Tribe, aged 71 years, being swoorne saith:*—That about ffifty years since this

* Possibly one of the crosses that he here refers to was the one sculptured on the "Spanish Rock," with the date 1543 still legible, but he may also refer to the wooden one on Cross Island, which could hardly have lasted more than thirty or forty years, in that situation.

As Governor Butler understood the Spanish language, and probably Latin also, it is singular that he did not translate and record the inscriptions on the "brass tablets," had they been known to him. Probably they were discovered after he left the islands.

depont. was ashore upon the Island of Ireland, with one Captn. Dickinson,* deceased, and ffound there three heaps of stones in a tryangle and a yellow wood tree, on which was severall letters or names, the discovery thereof much reffresht the memory of this depont. of what he had often heard his father and other antient men of these Islands say, viz. that there was such marks and signes left by some Spaniards belonging to a great ship cast away thereabouts, being richly loaden, and had there put on shore and buried a great part of their treasure and covered it with their ships hatches, which putt this depont. with some others upon serch and digging upon Cross Island, neare Ireland At the same time this depont. was possest with a panick ffeare, unwilling to make any ffurther prograce in serching or digging

This depont. ffurther sayth that the three heapes of stones and yellow wood tree were directly opposite to Cross Island and that he saw the stump of the tree, on which was the cross, one hand thereof pointing to Spanish Point, the other hand directly to the three heapes of stones and yellow wood tree, as this depont. hath been credibly imformed.

This depont. ffurther sayth that he hath often heard his ffather say that there was a Spanish ship came to ffetch the money left on these Islands, but on their approach to ye Castle harbour mett with a shott from thence discharged by the then Governor, which soe astonished them, ffinding the Island to be inhabited, that they dispared of pursueing what they came for†

JOHN KEELING."

"Sworne this 27th day of November, 1693. Before his Excellency the Governor, JOHN GODDARD."

"*The Deposition of Captn. Samuell Brangman, Commandr of one of their Maties. fforts called Southampton ffort here in these Islands, who deposeth and sayth:*"

"That since his childhood this depont. hath ever heard much discourse of great treasure hid in the Island called Cooper's Island and that three yellow wood trees wch stood in a tryangle, upon one of which was a brass plate and cross thereon & upon the other two

* Probably Francis Dickenson, Capt. of militia in Southampton parish, 1678–86.

† This is, apparently, an independent and direct traditional account of this occurrence, narrated by Governor Butler, in 1619, but not published at the time of these depositions, except in Capt. Smith's history, which was probably then unknown in Bermuda The father may have been a witness of the attack.

yellow wood trees were severall names or letters putt thereon, and that the tree the cross and brass plate was upon was cute downe about ffifty years since, as this depont. is informed. And this depont. ffurther sayth hee hath seen the same tree under water within these few yeares and can goe to the said tree at any time, and this depont. ffurther sayth that the place where these trees stood has alwayes been called by the name off Brassen Valley from ye several markes of brass sett and left there by the Spaniards, and this depont. further sayth that he hath often heard the successour of one Mr. Carter* say that the said Carter had found a considerable quantity of Ambergreese on the Cooper's Island, and he the sd. Carter carried the said Ambergreece for England and presented the Company or Propriets. of Bermuda, with a good part thereof, upon which the said Company would have settled upon the said Carter a certaine Island in Bermuda called Davids Island, but the said Carter rather asked of them the Island called Cooper's Island for that he beleeved he might discover much treasure there hid, which Cooper's Island was conferred on him & the Island called Davids Island by him refused, though twenty times the intrinsick vallue. SAMUEL BRANGMAN."

"Sworne this 27th of Novembr. 1693, before his Excellency the Governor, JOHN GODDARD."

There is also, a deposition by Mr. Joseph Ming, a grandson of Christopher Carter, which is practically identical in parts with that of Capt. Brangman. Mr. Ming was then (1693) still living on Cooper's Island. It is possible that the ambergris referred to as found by Mr. Carter and taken to London, may have pertained to the original large mass, found in 1610. There was evidently some interesting secret history, connected with this transaction, which probably will never be known, for Governor Butler intimated that the land was given by the Company "in gift for three lives," to Mr. Carter, who had begun "to undertake some dangerous courses," by the advice of others. At a later period, however, Cooper's Island was considered as public lands, though a "royal lease" to Carter is mentioned, and also a deed in 1627 of the property rights to Capt. Folgate, by the heirs of Carter, soon after his death. (See p. 546.)

* This was Christopher Carter, one of the three men of Sir Geo. Somers' party, who remained on the islands for two years (1610–12), prior to the settlement. (See pp. 517, 546, and note to next deposition.)

"*The Deposition of Mr. Joseph Ming of Cooper's Island, being the south east point of the Island of Bermuda, who deposeth and sayth:*" "That there hath been ever since his time a great discourse in these Islands, by the antient Inhabitants, that a great treasure hath been hid in this said Coopers Island and likewise that the marks and signe of it were three yallow wood trees, that stood tryangular, upon one of w'ch was a plate of brass nailed, and on the other were severall names or letters cutt thereon, and that this depont with some others to his assistance did about two years since endeavour to discover this treasure by digging in a peece of ground lying in the center of this tryangle of trees, for five or six dayes, but mett with noe success therein, soe grew soe tired and left off, not being able nor willing to bestowe any longer time or paines, therein, although the ground was very easye to digg, and that the place they digged was foure or five yards square. And this depont further sayth that by the report of old standers on this Island about fifty yeares since, one Capt. Seymour did cutt down one of the three trees aforesaid, on which was the plate and cross, which was designed by the said Capt'n Seymour to be sent home for England, to the proprietors of these Islands, which tree was carryed to the water side and fastened with a rope to a boate and towing it away the rope broke and the tree sunke immediately and could not be recovered without too much trouble and charge, and still remaines where it sunke, and hath been often seen by severall persons (and this depont hath seen the said tree within four or five years). And this depont further sayth that his grandfather had an extraordinary confidence of finding great treasures here from the satisfacon of the tradition and markes here found, upon which about sixty yeares since this deponts grandfather* went for England and made his application to the proprietors to purchase this said Coopers Island and carried with him a considerable quantity of Ambergreece and presented the proprietors with a good part thereof,† upon which the proprietors offered him

* His grandfather was Christopher Carter.

† Governor Butler, about 1624, gave an account of this transaction which is quite different, as follows.

"He [Carter] at his time by infinite importunitie, in recompence thereof, received of the Company in gift for three lives (who found that he began to undertake some dangerous courses, by the counsell of some wiser than himselfe) a small Iland called Coopers; but with such cuninge conditions, one whereof was to keepe continually a certaine number of resident men upon it, to be upon all occasions at the service of Pembroke Fort, which stands ther (the forte with the appurtenances being neverthelesse excepted from him) as let the world knowe, bothe how well they could laye about for themselves, and with what a foole they had then to deale withall."

Davids Island in lieu of his pesent which consists of tenn times more land and intrinsick vallue then this Coopers Island, which he rather chose than the said Davids Island for the hopes he had as aforesaid, and likewise oblidged himselfe to the proprietors to mantaine seven men continually at his owne charge towards manning the forts of the said Islands.

JOSEPH MING."

"*The Depositions of Mr. John Hurt, senior, of Tucker's Town, an antient inhabitant of these Islands, who deposeth and saith:*"

"That there was upon Cooper's Island a yellow wood tree upon which was nayled a copper plate with a cross engraven upon it, with an inscription underneath, alsoe a great cedar tree oposite to it, upon which was engraven or carved many lettrs. Tryangle to them was a great heape of stones round about a Spanish jarr buried in the middle thereof, and on the middle of these tryangles was a leavett or plain piece of ground, which would never bare anything planted or sown thereon, though many tryalls have been made time after time in vaine, untill the said yellow wood tree were cutt downe, after which itt became as ffertill as any other ground.

And this depont. ffurther sayth there was a person here accounted an expert astrologer, by name Ffrancis Jones, who informed one Mr. Ffarmer, a man of good repute here in these Islands, that in his opinion there was a great treasure hid in said Coopers Islands, which said Ffarmer did informe this depont. that the way to ffind it was by stretching or running a line in this tryangle, and this depont. ffurther sayth that hee with sundry others dugg downe ffour ffoote under ground and ffound the under part to be like marll or rock.

And this depont. ffurther sayth that he has sundry times seene fire drakes rise out of the said place or ground, and assend the aire towards Ireland, by which scimtomes or marks this dpont. supposes a great rich shipp or Spaniard to be cast away or lost right off from this Cooper's Island and that the people or Spaniards belonging to the said shipp gott on shore and buried some wealth in the tryangle or bare place aforesad." . . . .

The mark of JOHN HURT, senr.

d.—Other Native Trees and Shrubs partially destroyed.

Governor Moore, in 1612, stated that there were but four "timber trees" on the islands. Besides the Cedar and Yellow-wood there was a third, which he says was similar to the Yellow-wood (perhaps only in quality), but its wood was white.

This tree has not been identified satisfactorily. It may have been a tree now entirely extinct. The fourth, which he described as like Lignum-vitæ, is now unknown. Possibly it was the black mangrove.

The native Wild Olive. (*Forestiera porulosa* Poir.)

This is now a rare native shrub, which was probably common originally. In recent years it has been found in Bermuda only at Walsingham and on Boaz Island, but it occurs also in Florida, Texas, and the West Indies.

It has been thought by some that it was the "wild olive" of the early settlers, but without any sufficient evidence, as I have stated, in discussing the true olive.

It was, undoubtedly, much more generally distributed when the islands were first settled, and has been nearly exterminated by the clearing of the lands.

The leaves are thick, 2–4 inches long, lanceolate or elliptical, entire, blunt, wedge-shaped at base, usually shining above, dotted below. Flowers small, 4-parted, apetalous, in small racemes. Berries one-seeded and one-sided, elliptical, one-third of an inch long, or nearly as long as the pedicel, covered with a bloom.

Olive-wood Bark. (*Elæodendron xylocarpum* Del.)

A rare small tree, now found only in the Walsingham woods. In the early days of Bermuda this native tree was cut down for tanning purposes, on account of its astringent bark.

Later, the cutting of it was restricted by law, but it has now become nearly extinct. From the early records, it is not easy to ascertain whether the laws restricting the cutting of "Barke" for tanning purposes applied to this or to the Button-wood Tree, for both were used for tanning and both seemed to have been called "barke." It is also native in the West Indies.

The leaves are thick or leathery, 2 inches long, oblong or obovate, subentire, tapering to the short petiole. Flowers small, in short, axillary cymes; petals and stamens five; berry large ovoid.

The Button-wood Tree; Sea Mulberry; Barke; Zaragoza Mangrove. (*Conocarpus erectus* Linné.)

This native tree, if correctly identified, was considered valuable by the early settlers, because it proved to be the one most suitable for the tanning of leather.*

* Tanning leather is referred to as a trade in Bermuda, Oct., 1651, and the tanners were complained of for doing bad work. Therefore the Council ordered inspectors appointed for viewing the leather.

In 1676 complaint was made that not only natives, but strangers, were in the habit of cutting down the trees and even digging up the roots for this purpose, thus threatening its extermination.

Therefore a law was passed prohibiting digging up the roots and requiring that a stump at least two feet high should be left in every case (doubtless for sprouting). The penalty was a fine of 10 shillings for every root destroyed.

In a proclamation by the governor, 1679, the use of the Button-wood Tree for fuel was prohibited.

At present, this is called Button-tree, and sometimes "Bark," and "Alder." Governor Lefroy thought it identical with the Button-wood Tree of the early settlers. It is common, near the shores in many places. It is also found in Florida, Brazil, and the West Indies; also on the coast of Africa

A combretaceous tree, with lanceolate or elliptical, alternate leaves, often downy at base. Flowers in small, round pedunculate heads, small, apetalous, calyx tube not longer than the ovary; limb five-lobed; stamens five or six. Achenia imbricated, scale-like, rounded, concave and keeled above, convex below.

Mangrove. (*Rhizophora mangle* L.)

PLATE LXVIII FIGURE 2 PLATE LXXIV FIGURE 1

The true mangrove forms dense thickets in the upper parts of many shallow bays and coves, but they appear to be much less extensive than formerly, in most cases. Probably the more accessible trees have been cut for fuel.

These trees are profusely branched, with thick evergreen foliage; they mostly grow 15 to 20 feet high, and often stand in sea water two or three feet deep, sending down a profusion of large ærial roots, from the lower branches, and from the lower part of the trunk. These serve to entangle floating leaves, branches, seaweeds, and mud, and afford shelter to the handsome and active mangrove crabs, which burrow their holes among the roots, and ascend the trees with great agility when pursued. Several species of marine mollusks attach themselves to these ærial or half submerged roots, including the bivalve, *Perna*, and several spiral shells, such as *Littorina*, etc.

One of the largest mangrove swamps is at the upper end of Hungry Bay; others may be seen at Mangrove Bay; Spanish Point; Tucker's Town lagoon; Walsingham Bay, etc.

This tree is here smaller and far less luxuriant than on the coasts of Florida and Central America, where it forms vast seaside

morasses. The seeds will germinate while floating at the surface of the sea-water, with other debris, and sending long roots down to the bottom they soon anchor themselves, even when the water is two or three feet deep. It extends through the West Indies, and to Brazil; also to West Africa and the Pacific Islands.

Black Mangrove; Olive Mangrove; Black Jack. (*Avicenna nitida* Jacq.)

PLATE LXXIV FIGURE 1

This is a very common, thickly branched, evergreen tree of the Verbena family, with dark green, thick, entire, glossy leaves. Flowers small, white, in clusters. Fruit leathery; one-seeded.

In size and general appearance it resembles the true mangrove, and grows associated with it, in the borders of salt swamps and ponds and on marshy shores, often standing in the edge of the salt water; sometimes it grows in comparatively dry surface soil, but close to the shore. It usually sends up from its roots a multitude of slender, leafless, upright shoots, when it grows in the water. These serve to entangle mud, dead leaves, seaweeds, etc, to enrich the soil. It has no descending aerial roots, like those of the true Mangrove. The wood is very dark, hence the common names. It is found from Florida to Mexico and Brazil, and throughout the W. Indies; also on the coast of West Africa.

27.—*Introduction of Useful Plants and Injurious Weeds.*

It has been shown in a former chapter (p. 572) that the native flora contained scarcely any plants that could furnish human food, except the palmetto, which yielded the nutritious cabbage-like tops and edible berries; the cedar, whose berries were astringent, but were eaten in times of scarcity; the prickly pears, whose fruit is nutritious, but not very palatable; the wild mulberry; and a few other small berries. But there were no edible roots, nor cereals.

Therefore it was necessary to at once introduce and cultivate edible plants, in order to avoid the risk of famine, for the early communication with England and Virginia was slow and precarious.

a.—Introductions of Useful Plants from England, 1610–1625, by Seeds and Cuttings.

There is no evidence that any of the seeds that were planted by Sir George Somers in 1609 (see p. 543) came to anything. But the three pioneer men left on the islands from 1610 to 1612 had success-

fully cultivated corne (maize), pumpkins, melons, beans, peas, tobacco, and other garden vegetables not recorded. (See p. 545.)

The first party of settlers, according to Hughes and Governor Moore, succeeded in raising a good crop from the seeds that they planted, although they arrived in July. Probably they had the benefit of the experience of the three pioneers, and were favored with a wet summer. Moore stated that the first settlers planted at that time "four score and one" kinds of seeds, but only a few were named by him, among which were the melon and cucumber. Their next crop was nearly a failure, according to Hughes (see p. 549), and probably many kinds of plants, that they tried, died out at once.

Probably parsnips, radishes, carrots, turnips, beets, lettuce, and the English artichoke were introduced at this time, if not by the pioneers in 1610; the first two were mentioned as abundant, by Governor Butler, in 1619, and Capt. Smith mentioned the artichoke in 1624.

American potatoes, which had then been known in England for only about sixteen years, were sent over by the Company in 1613 and planted. They increased rapidly, but through carelessness were nearly lost again soon after, but the supply was replenished from two stray tubers, accidentally found. From these they soon obtained a large increase. A shipment of 20,000 lbs. of potatoes to Virginia, which is recorded even in 1620, well illustrates their rapid increase.

Indian corn, first raised in 1610, was at first, and for many years after, the principal article of vegetable food, though sweet potatoes, common potatoes, and pumpkins were largely used.

In the Commission of Governor Tucker, February, 1616, reference is made to the various seeds that were sent out, at that time, with directions for planting them and caring for the young plants. Among the plants then sent were grape vines and vine cuttings, with directions to plant new cuttings every year, the seeds of anise, cummin, sweet fennel, sweet marjorum, basil, onions, mulberry, oranges, lemons, and citrons.

Governor Tucker was described as a good gardener, and doubtless he planted and reared all these species, though most of them never became of any commercial importance, as the Company hoped they would.

The oranges, lemons, and grapes seem to have succeeded best, for seven years later, in 1623, a law was passed imposing penalties on those who should steal oranges, lemons, grapes, and other fruits.

There is no evidence that the Bermuda Company ever sent out the seeds of any merely ornamental plants or flowers, or of any shade or forest trees. Their efforts were wholly utilitarian, and especially for commercial purposes.

b.—Useful Plants brought from the Bahamas, 1616–25.

In 1616 a small vessel, the "Edwin," was sent to the Bahamas to obtain useful plants, fruit trees, and seeds. Doubtless slaves were also to be obtained, if possible. Her return, in the time of Governor Tucker, is thus recorded, in 1624, by Captain John Smith:

"Within a weeke after returned the Edwin from the West Indies, furnished with figgis, pynes [pine-apples], sugar canes, plantaines, papaues [papaws], and divers other plants, which were presently replanted, and since increased into greater numbers, also an Indian and a Negar, and so much ligna vitæ as defrayed all the charges." . . . "The Governor thus busied amongst his plants, making hedges of Fig trees, and Pomgranets, and several divisions of Palizadoes for the defence of their guarding and keeping their cattel, for in such husbandry qualities he well deserved great commendations"

Governor Butler's account of this arrival, written in 1619, is in nearly the same words, indicating that Smith used his MSS. account, but added a little to it from other sources Butler did not mention the Pawpaw, nor the Pomegranate, though he later spoke of the fences of Fig-trees made by the governor in 1616. He also said of these plants (1619), they "are since encreased into great numbers, especially the plantains and figges, very infinitly." He remarked that the Indian and Negro were the first that the islands ever had.

Among the "divers other plants" not named were, without much doubt, the sweet potato, cassava, and indigo, for these are mentioned by Butler as common, in 1619.

The "American bread-root," mentioned as introduced at this time, may have been the taro or eddoe (*Colocasia esculenta*), which is still sparingly cultivated; or the yam (*Dioscorea*), which was probably introduced at the same time and is still cultivated to a limited extent.

The date of the introduction of the Arrow-root is unknown. It may have been introduced in 1616, or at some other very early date. Lefroy states that it was introduced about the close of the 18th century. It was not cultivated on a large scale till about 1830. The dates of introduction of many other common cultivated plants are not known.

c.—Later introductions from England, etc.

In subsequent years, from time to time, the Company tried to introduce various plants for commercial purposes, but generally without any success. Persistent efforts were made to introduce the culture of silk-worms. The seeds of the white mulberry were sent, in 1616 and at other times, and in 1625 those of the black mulberry were also sent out,* together with some eggs of the silk worm moth.

Capt. Smith mentions saffron, indigo, and madder plants as cultivated in 1624, with promise of success. The seeds of hemp and flax were called for by Governor Wood, in 1632, when the people were destitute of clothing. At that time cotton trees were ordered planted on every share of land. Castor-oil plants were extensively raised for oil in 1632–33, but were not profitable. (See p. 523.) Probably this plant was native of the islands, but seed may also have been sent there and not recorded.

In the poetical description of the Bermudas written in 1670–71, by John Hardie, he refers to many of the common plants and fruits, and to a few not mentioned by other early writers, as the guava and the lime. Doubtless seeds were constantly brought from England and planted almost every year, after the first settlement.

As the Bermudians also kept up more or less trade with the Bahamas, Turks Island, Barbadoes, and other West Indian islands, tropical seeds and plants were often brought from there, both for use and ornament, without being recorded. Doubtless most of the earlier shade trees and flowering plants were thus introduced.

Several Governors and many prominent citizens have taken great interest in introducing foreign plants. Among others, Governor Reid, about 1839, introduced many useful and ornamental species.

Governor Lefroy, 1872–76, probably introduced more species than any other individual.† In his catalogue of the Bermuda plants he

* The American red mulberry, which is still common, was probably native there, and was most likely the wild mulberry used as fruit by the earliest settlers.

† It seems singular that no special effort has ever been made to introduce forest trees that might be useful for timber, to supplement the cedar. Doubtless there are numerous valuable West Indian, Australian, and New Zealand timber-trees that would flourish on the barren Bermuda hills as well as the cedar, if not better. The fiddle-wood tree has rapidly spread itself over the islands, but its timber is of little value. Governor Lefroy tried many species, in small numbers, with varying success. Some of the species of *Eucalyptus* planted by him (usually a single tree) gave promise of success, but other species should also be

has given a valuable annoted list of those that he planted, stating whether they lived or died, which is a very useful record. He received large numbers of plants from the botanical garden at Cambridge, Mass

d.—Accidental Introduction of Injurious Weeds.

Ever since the first settlement there has been a constant influx of undesirable weeds, mostly introduced accidentally or unintentionally. Many of these have come in by planting impure seeds of common cultivated plants, which are constantly imported. Many have undoubtedly been brought in imported hay, straw, and other merchandise. Others which adhere by hooks to clothing, the wool of imported sheep, etc., have thus been accidentally introduced. Some have certainly arrived by means of seeds contained in the earth adherent to the roots of imported trees and shrubs, or in the earth of potted plants.

By these and other means, large numbers of weeds, common in Europe and America, or in the West Indies, have been added to the flora, and having become completely naturalized, it is often impossible, at the present time, to tell whether they were indigenous, or introduced later by man. Some of the weeds have probably arrived from Madeira in the onion seeds that are imported in large quantities.

A considerable number, however, which were originally cultivated plants, have escaped from gardens and permanently established themselves in all suitable places, growing as freely and abundantly as if indigenous, until some of them have now become troublesome weeds.

As examples of this mode of introduction we may mention the scarlet sage (*Salvia coccinea*); the Mexican ageratum (*Ageratum*

tried, and on a larger scale, in many varied localities The English oak has flourished on the hot and barren volcanic plains of St. Helena, and possibly it might grow on the hills of Bermuda The American oaks planted by Lefroy did not flourish. Their foliage is very sensitive to salt spray, except perhaps the live-oak, which was not tried. Among American trees that resist salt spray, the cotton-wood, honey-locust, red-bud, and Kentucky coffee tree may be mentioned.

We should also expect that many of the trees and shrubs of southern Japan might also flourish here, and be used near the seashore, because many of them are very resistant to the action of salt spray. On the New England coast the Japanese or "California" privet; the Japan rose (*Rosa rugosa*); and the Japan thorn (*Eleaginus*) are all remarkable for their resistance to the action of sea water. The S. Pacific Araucarian pines and the Bahama pine should be fully tried.

mexicanum); red head (*Asclepias curassavica*); flax (*Linum usitatissimum*); several species of morning glories (*Ipomœa dissecta*, *I. nil*, *I. villosa*, *I. Learii*, etc.); life-plant (*Bryophyllum calycinum*), (see p. 432); indigo-plant (*Indigofera tinctoria* L.); red periwinkle (*Vinca rosea*); cigar-plant (*Russelia juncea*); candelabra-flower (*Cleome speciosa*); oleander; the lantannas; aloe (*Aloe vulgaris*), etc.

At the present time much the larger part of the herbaceous vegetation, including the grasses, consists of introduced species, and the same is true of the shrubs and deciduous trees. Aside from the cedar and palmetto, the native plants make but little show, except in the marshes.

e.—List of Principal introduced Fruits and Fruit Trees.

In a former chapter a general historical account of the cultivation of some of the fruits, formerly of commercial importance, has been given. In this place, most of the fruits that are now, or have formerly been cultivated for domestic use, will be enumerated or discussed, with additional historical data. The sequence here followed is, in a general way, that of their successful introduction and historical importance for the common fruits; those of later introduction, or of less importance, are placed in botanical order in the last part of the list.

The following list of fruit trees is not supposed to be complete, for many unusual species are probably cultivated in some of the larger gardens that we did not see. As most of the fruit does not ripen at the seasons of the year when we were there, I have depended largely on the statements of Lefroy and others, as to the relative abundance and quality of many of the less common fruits, supplemented by such information as could be gathered personally during our short visits.

Banana (*Musa sapientum* L.) and Plantain (*Musa paradisiaca* L.)

FIGURE 6; AND PLATE LXXIV; FIGURE 2.

Probably the early historians did not make any distinction between the banana and plantain, but included all varieties under the general name of plantain (or sometimes, "plants"). Governor Butler, in 1619, and Capt. Smith, in 1624, mentioned "plantans" as abundant at those dates. They were first brought from the Bahamas in 1616, but they can be propagated very rapidly. They have been largely cultivated ever since their first introduction. Various more choice

varieties of bananas have, however, been introduced in modern times, so that the original large and coarse plantains are now little cultivated. Governor Lefroy enumerated four principal varieties of true bananas as cultivated twenty-eight years ago, which appear to be the same that are still preferred.

1. Dwarf Banana (var. *Cavendishii*). This is by far the most common variety. It is very productive and produces fruit at nearly all seasons of the year. When well cultivated in good soil, the bunches sometimes weigh over 70 pounds. The summer fruit ripens in 90 to 100 days; but the winter crop requires 140 to 160 days.

2. Thumb Banana. A small but very delicately flavored variety, considered to be the most choice of all, but not very productive and therefore less cultivated. Its flavor is subacid.

3. Red Banana (var. *rosacea*). Not much cultivated at present. Its fruit requires nearly twice as long to mature as that of the dwarf variety, and its broader foliage requires more shelter from the winds.

4. Old Bermuda Banana. A tall variety that has been cultivated for a long period, but is now rare; perhaps it was one of those introduced in 1616. The fruit is of good quality, but requires longer to mature than the dwarf varieties.

Pine Apple. (*Ananassa sativa* Moll.)

Pine Apples were introduced into the islands from the West Indies, in 1616, when the "Edwin" returned from her voyage there to obtain plants of various kinds. They evidently flourished well at that time, and for long after.

Governor Butler enumerated them among the common productions, in 1619. Capt. John Smith spoke of them as abundant, in 1624. They are also mentioned, as if common, in various laws and proclamations, in 1623 and later dates.

Governor Roger Wood, in 1633, wrote as follows: "I wish I could send 1000 in their season to the Queene, and 500 more to such as desire them, for I can well spare them and eat enough myselfe. I sent four boats lading this year into the mayne, to give them to those good dames that love to eat them better than to plant them, and I assure you I love to plant and preserve them, and behold them in their beauty, more than to munch them alone without the companie of my friends."

John Hardy mentions the Pine Apple as the most choice fruit, in 1670. It is not now cultivated for the fruit, unless experimentally.

Pomegranate. (*Punica granatum* L.)

The Pomegranate was enumerated among the plants brought from the Bahamas, in 1616, by the "Edwin." It increased very rapidly and was commonly used, with the Fig-trees, for making hedges a few years later.* The variety first introduced was valued for its fruit, but in later times other varieties with beautiful double flowers have been cultivated for ornament. Both are now very common and frequently used for ornamental hedges.

The following law was enacted by the Assembly, August, 1620:—

"And further it is enacted and concluded by the power and authoritie aforesaid that in regard divers and many negligencies have of late been committed and suffered both in the over felling of fences in generall and the ill keepinge and lookinge unto them, that every man be enioyned to leave and mayntayne a verye sufficient fence both upon his owne ground and aginst other mens that he is to fence upon and where the natural Palmetoe fence is failed and is found to be wantinge, that instead thereof there be planted a sufficiencye of Pomgranate and figg trees for a supplie thereof, and this to be done upon the penaltye of the losse of tenne pounds of tobacco for every such breach contempte or negligence."

The Assembly in March, 1627, passed an act ordering every tenant and owner of land to plant 50 Pomegranates and 50 Mulberries on every share of land for three years, next ensuing.

In modern times, although common enough, it seldom produces much fruit.

Pawpaw. (*Carica papaya* L.)

Plate LXXIV Figure 2.

This singular fruit tree, which belongs to the passion-flower family (Passifloræ), was brought from the Bahamas by the "Edwin," in 1616. It increased rapidly and soon became common, bearing fruit freely. It is now generally diffused, but there are seldom more than two or three trees together; more often they stand singly. There are two varieties cultivated in Bermuda. This tree was originally from South America, but has long been cultivated in the West Indies.

It is easily recognized by its naked, columnar trunk, occasionally forked, with a relatively small tuft of large palmate leaves at the summit. The fruit, which is about the size of an orange, forms large

* There is no evidence that it was native, in 1612, as Lefroy supposed it might have been, for none of the earlier writers mentioned it among the native fruits.

clusters around the trunk just below the leaves; it is not very highly prized, but is sometimes cooked as a vegetable.

The sap of this tree contains a vegetable ferment, called *papain*, which has the power of digesting meat.* This has recently become an article of commerce. It has long been known to the natives of the West Indies that meat wrapped up in its leaves, or treated with the juice of the fruit, would soon become tender. The leaves are also popularly considered an excellent remedy for the rheumatism, applied externally.

The Fig Tree. (*Ficus carica* L.)

The earliest accounts (1612) do not mention the fig as growing wild on the islands, though wild figs are recorded a little later. The fig tree grew so rapidly there that the wild figs referred to by Governor Butler may well have been derived from seeds planted there in 1609 or 1610, by Somers' men, or even from those planted in 1616, by Governor Tucker. It was stated that the fig trees would bear fruit the second year from planting. But it is not improbable that the wild figs first noticed may have been introduced, like the olive, previous to 1609, by the Spanish shipwrecks or by the pirate crews. (See p. 633.)

The fig is not native of the West Indies, but probably was introduced there very soon after their discovery. If not already there, fig trees were introduced by the Edwin, very soon after the settlement of Bermuda. Governor Butler states that Governor Tucker, in 1616, was engaged in setting out fences of figs and pomegranates. They seem to have increased very rapidly, and the fruit was mentioned as abundant in 1620. The drying of figs for food is recorded in 1623.

In 1618 a public order was passed, requiring Capt. Thos. Stokes, commander of King's Castle, to lay out a highway, twelve feet wide, from Tucker's Town to the landing at the eastern end of the Island, at Castle Point, for military purposes, in reaching the fort.† He

* See Trans. Conn. Acad., vol. xi, pp. 1–14. Observations on the Digestion of Proteids with Papain, by G. B. Mendel and F. P. Underhill.

† Governor Lefroy thought that this order indicated that there was then land connection from the point to the island, which has been since worn away by the sea. But this was not the case, for Captain Stokes was also paid for the use of his boat in crossing from the point to the Castle Island, which is only a short distance. Moreover, Norwood's map of 1626 shows the channel as it still exists.

was required to plant it on each side with figs and pomegranates. The path seems to have been made in some sort of a way, but he obtained other grants for clearing it out in 1625 and 1626, but was accused of not having done his work as agreed.

Whether he planted the figs and pomegranates is not stated,* but no trace of them can now be found there. That whole narrow strip of land is now barren and too much exposed to the salt winds on both sides, for the growth of such plants. But the order indicates that the practice had then become common.

A law was enacted by the Assembly, in 1620, requiring figs and pomegranates to be planted in the hedges or fences wherever the native palmettoes, formerly used for that purpose, had died out. (See p. 629.)

In a proclamation by Governor Bell, in 1627, he complained that persons unlawfully robbed his "vineyard" of "figgs," "pown-granates" (pomegranates), lemons, and oranges, though he intimated that he had but few lemons and oranges.

A law was passed in (1630) forbidding all persons from picking figs from the land of another, or from the public lands in "baskets and tubs," though they might pick them for their own eating. Capt. John Smith (1629) stated that figs were then very abundant.

An intoxicating fermented liquor was soon made from the figs and called "Figg-drink." The sale of it to apprentices was prohibited in 1627. Prosecutions for the unlawful use of it are recorded in 1630.

In March, 1631, John Bunnion was indicted for stealing "a caske of figge drink," and there are several indictments for drunkenness and riotous conduct (stabbing in one case), as a result of using this drink.

An order was also promulgated by Governor Heydon, in 1669, requiring figs and cedars to be planted along all the highways, which were to be 12 feet wide. This indicates that horses and carts were not then in use.

Figs had become so abundant on the common lands of St. George's, in 1642, that a special code of rules or laws was enacted to regulate the number of hogs or "shoates" those persons having a share in

* It is doubtful if this was ever done as ordered, for Captain Stokes was subsequently charged with fraud and neglect of duty in connection with this path, etc. He was tried and convicted of evil practices in 1627, and dismissed from the service. He was then an old man, addicted to drinking and riotous living, and was thought guilty of selling the public store of powder to obtain liquors. He had been for many years in command of the "King's Castle."

the lands might allow to run loose and feed on the fallen figs, but beating off the figs with sticks, and cutting and pruning the trees, were forbidden. This indicates that figs were one of the principal sources of food to fatten the hogs at that time.

At present figs are by no means abundant, though wild trees are often seen in waste places and in the woods, where they look as if they had grown spontaneously.

These figs must have belonged to a variety that is capable of self-fertilization, like those now grown in the West Indies, and not to the choice Smyrna variety, which requires caprification. There is no evidence that the practice of caprification has ever been tried in the Bermudas. But there seems to be no reason why Smyrna figs should not be introduced, and also the caprifying insects, for they have succeeded in doing so in California.

Olive Tree. (*Olea Europæa* Linné.)

PLATE LXIX

Wild Olives were not mentioned by members of Sir George Somers' party, in 1610, as growing on the islands.

But in Governor Moore's report or letter of 1612, he says: "Alsoe we have olives grow with us, but no great store."

Governor Butler, in the early part of his "Historye" (1619), distinctly stated that there were wild olive trees when the islands were first inhabited He had with him there, when he wrote his work, some of Somers' shipwrecked party, including Christopher Carter, who had remained on the islands for the three years subsequent to the wreck (1609–1612), and before the settlement, so that he had opportunities to know the original productions of the islands better than any one else, except his two companions. But it has been doubted whether these accounts refer to the true Old World olive, for there is a native shrub of the same family (*Forestiera porulosa*) which slightly resembles the real olive, but produces a very inferior fruit. (See p. 620.)

It seems to me probable that men as well informed as Governor Butler and his companions, and as well acquainted with olives as they must have been, would not have made such a mistake. It is more likely that the olive trees, like the wild hogs, had been introduced there in small numbers, some years previously, by the Spanish pirates or buccaneers, either accidentally or intentionally, by planting seeds. It is even possible that the Spanish crew wrecked there with Henry May, in 1593, may have saved olives from the wreck with their other

provisions, and if so, they may have planted the seeds. As it took about 20 years for the olives planted later to commence bearing, these wild olives, if real ones, must have been introduced as early as about 1593, so that they might have been planted by May's comrades.

Probably the Bermudas, like many other uninhabited islands, were often visited by the Spanish buccaneers and pirates of the 16th century, for wood and water and for repairs. It is well known that they were in the habit of leaving hogs and goats on uninhabited islands, in order to be able to secure fresh provisions, in such remote and secret places, when needed, or when they visited such islands to careen and repair their vessels.

The Bermudas, dreaded as they were at that time, both by the commercial and naval vessels of all nations, would have afforded pirates an admirable chance to land and repair their vessels, while they could have obtained an abundance of fresh provisions from the birds and their eggs, the sea-turtles, fishes, etc. It is not unlikely that at such times they may have introduced both olives and figs.

It is not unlikely that they may also have introduced many other fruits and edible vegetables, as they often did on other islands. But if so the great increase of the wild hogs would probably have soon led to the extinction of all those plants that they could eat.* (See ch. 26.)

The Bermuda Company made very early efforts to have olive trees planted. They sent over seeds, with directions for planting them, at several periods, and the trees began to bear fruit about 1640, but no great use seems to have been made of them. Perhaps pickled green olives were not then in use there.

Mr. Richard Norwood, the engineer, having made some olive oil in 1660, the Councell ordered that ten olive trees should be planted on every share of land in the islands. But there is no evidence that this attempt ever became of commercial importance.

* Hogs and goats, which were placed on St. Helena in 1518, increased to such an extent, especially the goats, that in the course of about three centuries they utterly destroyed the thick forests of native ebony and other trees, as well as nearly all other vegetation, converting the previously well wooded high plains into a barren waste of volcanic rocks. Even in 1588, Capt. Cavendish, who visited the island at that time, said that the goats had so increased that they existed in flocks over a mile long, containing thousands.

By 1810 the forests had been entirely destroyed, except on the high, central volcanic peaks, and many of the remarkable endemic species, including the once abundant ebony, had become nearly or quite extinct. At present the vegetation of the plains has been only partially replaced by plants of foreign origin.

Governor Lefroy (1877) stated that there was a venerable olive tree still standing on Norwood's ancient property, close to the house where he resided, but that the olive trees were then rather scarce, and no use was made of the scanty fruit.

Governor Sayle, in his proclamation of May, 1662, says in regard to the planting of olive trees :—"wee haveing had experience thereof these 40 yeares, twenty yeares whereof they have boorne olives, but have not produced any profitt. Wee together with the Assembly have returned our answer to the Honorable Company accordingly."

But yet, in accordance with the orders of the Company, he required that two olive trees should be planted at once on each share

Some fine old trees, that may have been planted at that time, still exist. Young ones are common, growing wild. The largest one that we saw was near the southeast shore of Somerset Island. Of this a photograph was made in 1901. (Plate lxix.) Its trunk is entirely concealed by an immense number of tall sprouts. This tree, which has evidently had no care for very many years, and does not look as if it had ever been pruned, is perhaps two and a half feet in diameter at base. It must be very ancient, for olive-trees grow slowly. Possibly it was planted in 1662.

On the Walsingham place there are also many olive trees, some of them of good size.

Sweet Orange, (*Citrus aurantium* L.). Mandarin Orange, (*C. nobilis* L.). Lemon, (*C. medica*, var. *limonum* Risso.).

A brief history of the cultivation and decline of the orange and lemon trees has been given in a previous chapter (p. 526). It is not probable that Bermuda can again successfully compete with Florida, California, etc., in supplying the American market with these fruits, but a sufficient quantity of choice fruit might be grown to supply the local demand, at the hotels, etc.

But in order to do this improved and vigorous varieties should be introduced and kept up by grafting, and the improved modern methods for destroying the scale-insects and other injurious species must be adopted. A great quantity of literature relating to this subject, published by the U. S. Department of Agriculture, is now easily available.*

* The most effectual and cheapest remedy for destroying the scale-insects is the fumigation by means of hydrocyanic acid gas (prussic acid gas) generated under cloth tents placed over the trees. But as this gas is very poisonous to man, it should be used only by careful persons, trained for this work.

All imported nursery stock should be at once carefully inspected, to prevent the introduction of other and perhaps still more destructive scale-insects. Any infected stock should be burned or else fumigated at once, with hydrocyanic acid gas.*

I could find no evidence in Bermuda of the presence of many of the most pernicious scale-insects that infest the Florida and California citrus trees. Therefore, there are good reasons for special laws to keep out these dangerous species, some of which attack various other fruit trees as well.

So little careful attention has been paid to the study of these small but pernicious insects in Bermuda, that little can now be learned of the species that caused the former destruction of the trees. It is natural to infer that those still found on the surviving trees are the same, but this is not certain.

It is recorded that Governor Reid, about 1844–48, introduced new and choice varieties of oranges, which flourished for a time. Possibly he introduced the destructive scale-insects on those plants, for they became abundant and destructive soon after that date. Had effective measures been promptly taken, the pest might have been easily stayed at first. But the modern methods of destroying scale-insects by kerosene emulsions; or better, by fumigating the trees with hydrocyanic acid gas under tent cloths, were of course then unknown.†

However, it is certain that oranges had become scarce before Governor Reid's time. Bishop Berkeley, in 1837, spoke of their decline and scarcity at that time, and attributed it to the cutting of the cedars, which exposed the orange trees to the blighting winds. But perhaps he and others overlooked the scale-insects that may have been at work even then. Mr. Williams, writing in 1847–48, also speaks of the oranges being then scarce.

* Some American dealers in nursery stock now fumigate their plants before sending them out. It would be well if all were required by law to do this. Sooner or later those dealers who can furnish disinfected and guaranteed stock will gain most of the trade. Buyers should demand such stock.

† It is doubtful if sufficient energy or interest in the matter could then have been aroused in the Bermudian planters, generally, to have induced them to apply such remedies extensively, even if they had been known, for most of the smaller cultivators are inclined to "take things easy" and trust to "Providence" in such cases. Trusting to prayers and Providence against infectious diseases and insect pests is, at the present day, only an excuse for laziness or ignorance, or both.

The Citron, (*Citrus medica* L.). The Shaddock, (*C. decumana* L.). The Forbidden Fruit, (*C. dec.*, var. *buxifolia* Poin.). The Grape Fruit, (*C. dec.*, var. *racemosa* R. & P.). The Lime, (*C. aurantium*, var. *spinosissima* Mey).

These are all cultivated, more or less, but are not abundant. They suffered from the same scale-insects that destroyed the orange trees.

Bitter Orange. (*Citrus aurantium*, var. *bigaradia* Duh.)

This is a very handsome tree when full of its large and handsome, but inedible, fruit or decked with its large and fragrant flowers. Its leaves are large, glossy, dark green.

Grape Vines (*Vitis vinifera* L.), and other species.

Numerous efforts were made to cultivate the vine on a commercial scale in the early years of the colony, but never with success, though more or less grapes have always been raised for domestic use.

The cuttings sent out from London by the Company in early times were varieties of the true wine grape of Europe. Among the plants mentioned as sent out with Governor Tucker, in May, 1616, were "vynes and vyne cuttinges." Cuttings of "white vines" are mentioned in a letter from the Company to Governor Tucker without date, but apparently late in 1616. They grew well but did not produce much fruit.

In a letter to Governor Butler, in 1620, the Company required that he should see that every owner or sharer of land should plant at least one acre of each share to vines and one acre to sugar canes, "of such ground as is fittinge." But the Governor, in reply to this part of the letter, said that he could "find not the grounds therof answerable to your hopes," and added the following remarks, according to his "Historye":

"Concerneinge vines here, I confesse they conserned me much this Springe, for so admirably wer they taken and sett at the first, that I verily thought to have presented you with a vessell of Sommers-Ilands wine, and to that end had them diligently tended and fenced, but when I expected their matureing, not one cluster of five hundred came to perfection, but groweinge into a kind of hardnesse and shyneinge like a horne, they still proved rotten instead of being ripe. Whence this cause of miscarriage and sicknesse proceedes some vigneron must tell you."

This description indicates that they were affected with some fungous disease. Probably the climate is too moist for this variety of

grape. Some more resistant varieties or species might be more successful.

Grapes were mentioned in a law of 1627, against stealing fruit, and at other dates, showing that they produced some fruit, as they do now. Large and ancient white-grape vines, like those of Spain, still exist, and are doubtless the direct descendants of those planted in 1616.

The vine here loses its leaves in November and begins to put out new ones in February, the bare period being about 120 days. Governor Lefroy imported and distributed many of the best English green-house varieties, some of which, in wet soil, bore large and fine fruit, within three years. He also mentions that white Lisbon grapes, washed ashore from a wreck, in January, 1873, germinated on the beach; some were successfully transplanted and bore fruit in 1876.

Probably it may be found that certain American hybrid grapes of the south would be more suitable for the moist climate than the white grapes of Southern Europe, but I do not know to what extent they have been tried. (For the amount of grapes now raised, see p. 532.)

The grape vines, like the orange trees and figs, have probably suffered much from the unrecorded attacks of various insects and parasitic fungi.

Avocada Pear; Alligator Pear. (*Persea gratissima* Gært.)

This fine fruit tree appears to have been introduced about seventy years ago. It is now common in the larger grounds and gardens.

Governor Lefroy stated that the finest tree on the islands (in 1876) was one in the grounds at Mt. Langton, planted about 1835.

It flowers in March and the fruit is in season from August to October, or sometimes to November. Large fruits sometimes weigh nearly two pounds. According to Governor Lefroy, it is more highly prized in Bermuda than any other fruit. He also stated that the trees are badly infested by a white coccus.

This tree is native of tropical America.

Akee. (*Blighia sapida* Kœn.)

This sapindaceous tree is native of West Africa, but is cultivated in the West Indies, whence it was brought to the Bermudas, but is still rare. It flowers in July and ripens its fruits in November. The fruit is red, three-sided, and about four inches long; the black seeds have a large, white, fleshy arillus, which is edible.

Lee-chee or Litchi. (*Nephelium litchi* Lour.)

A tree at Mt. Langton bore abundantly in 1871, according to Governor Lefroy. It flowers about February and the nut-like fruit, with aromatic pulp, is ripe in August. It was introduced about 1853, by Governor Elliott (Lefroy)

The Mango. (*Mangifera Indica* L.)

This is not very common. It flowers in February, March, and April; the fruit ripens in August and September. A tree at Mt. Langton bears abundantly (Lefroy). It was introduced by Governor Elliott, about 1853 It might well be more commonly cultivated. There are many choice varieties in the West Indies, that might be introduced without much trouble.

Spanish Pepper. (*Schinus molle* L)

Common. Native of Peru.

Sour Sop. (*Anona muricata* L)

Early introduced from the West Indies. Common.

Sweet Sap; Sugar Apple. (*Anona squamosa* L.)

Not common. Introduced from South America.

Custard Apple; Sugar Apple. (*Anona reticulata* L.)

Not very rare in old gardens. Easily cultivated. Introduced from South America.

Mammee. (*Mammea Americana* L.)

Found rather rarely in old gardens. The large, pulpy fruit ripens in September. Native of the West Indies, and brought to Bermuda many years ago.

Peach. (*Amygdalus Persica* L.)

Formerly the peach was extensively cultivated and produced an abundance of excellent fruit. About 1838 to 1850, it was the most important fruit grown here.

But diseases and insects were introduced and neglected till the trees nearly died or became useless. Some writers state that the cause was the "American peach fly," but I have not been able to learn the specific insect to which this name may have been applied.

According to Lefroy, this infection and destruction of the trees took place about 1864. At the time that he wrote (1884) he stated that scarcely a healthy tree was to be found.* Perhaps the insect was the peach-tree borer (*Ægeria*, or *Sannina, exitiosa*). The Bermuda peach is said to have been first raised from Madeira seed, at St. David's Island, by Lieut. Lang.

There is no reason why the peach should not again be cultivated with success, by using modern methods of combating insects and fungous diseases. Some American varieties tried by Lefroy did not bear fruit. Probably those varieties from the southern United States or Madeira would be most likely to succeed.

The Apricot, Nectarine, Sweet Almond, and the Plum have been planted by Lefroy and others, but generally without much success. Usually they do not produce fruit, though in some cases they have done so. Probably those varieties best suited to the climate were not obtained, in many cases. Further trials, with southern varieties, might succeed. The Apple and Pear do not succeed well, though a few of each have been raised, mostly as curiosities. They usually blossom, but seldom mature much fruit. The Apple blossoms in February and March. Those that I saw were generally planted in soil that was too shallow and sandy for such trees, but probably they require a longer winter rest than the climate permits.

Quince. (*Cydonia vulgaris* Pers.)

Flowers in April and May. Not uncommon and produces considerable fruit in moist soil, but the trees remain small and scrubby.

Loquat; Japan Medlar. (*Photinia*, or *Eriobotrya, Japonica* Lind.)

Introduced about 1850, from Malta, by Governor Reid. It is now common and bears abundant fruit of good quality. Flowers about September, and the fruit is ripe from January to March.

Strawberry. (*Fragaria Virginiana* Duch.)

Cultivated to some extent and often produces excellent fruit. The plants require to be renewed every two years. The fruit ripens about the first of January, sometimes earlier. With proper care and by using the most suitable varieties, large crops could undoubtedly be obtained. At present those used at the hotels are mostly imported.

The Raspberry has been repeatedly tried, but does not flourish.

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* The real Peach-fly (*Ceratitis capitata*) is a small dipterous fly that infests the fruit only.

Surinam Cherry. (*Eugenia uniflora* L.)

Common in gardens and also naturalized. Flowers mostly from February to May; fruit is ripe in most months, and varies much in size and flavor. It might be much improved by planting selected seed or by grafting from choice varieties. Those that we tested were less palatable than ornamental.

Rose Apple. (*Eugenia jambos* L., or *Jambosa vulgaris* DC.)

Not very common. The fruit, which is ripe in June, is about an inch and a half in diameter. The name alludes to the fragrance of the fruit, which is dry and not very palatable to most persons.

Allspice; Pimento. (*Pimenta vulgaris* W. A., and *P. acris* W. A.)

Both species are to be found in a few gardens.

Guava. (*Psidium pomiferum* L.=*P. guaiva* Rad.)

In gardens and also naturalized. Bears fruit irregularly, seldom abundantly, which is ripe in December or January.

Guava Berry. (*Psidium Cattleianum* Sab.)

Near Paget Church in a garden (Lefroy).

Grenadilla; Water Lemon. (*Passiflora quadrangularis* L.)

Cultivated to some extent, but not common.

The fruits of other species, which are less common, are also called Water Lemons, as *P. laurifolia*, *P. melifolia*. The fruits of the native species (*P. ciliata* Ait.), which is found wild at Walsingham, are called "Apricots" by the natives; the same name is used in South Carolina.

Water Melons and Musk Melons in many varieties are cultivated and produce abundantly, as well as the other cucurbitaceous fruits, such as Squashes, Pumpkins, Cucumbers, Gourds, etc. Most of these were introduced as early as 1612–1616.

Barbadoes Gooseberry. (*Peirescia pereskia* L.=*Peirescia aculeata* Mill.)

Not very common. A cactaceous shrub or small tree with distinct leaves; it bears an abundance of an agreeable acid fruit, in clusters. Native of the West Indies.

Coffee Tree. (*Coffea Arabica* Linné.)

Wild or half-wild Coffee Trees occur in many places. This tree was early introduced into the islands for cultivation, but I find no evidence that it was ever cultivated to any great extent, even for local use, though it bears fruit.

It is common on the Walsingham tract and at Paynter's Vale.

Sapodilla ; Naseberry. (*Achras sapota* L. or *Sapota achras* Mill.)

This evergreen West Indian fruit tree is not yet very common. The russet-brown fruit, which is ripe in July and August, is about the size of a quince ; its soft pulp is very sweet.

Persimmon. (*Diospyros Virginiana* L.)

Cultivated in a few gardens, but not thought of much value. It might be used for windbreaks near the shore, for it resists salt spray and spreads rapidly by root suckers.

Perhaps the Japanese Persimmon might be of much greater value for fruit, but I am not aware that it has been cultivated. Some of the varieties produce large and choice fruit in Florida.

Egg Plant. (*Solanum melongena* L.=*S. ovigerum* Dun.)

Cultivated for domestic use.

The Tomato (*Lycopersicum esculentum* Mill.) has been discussed in a previous chapter (p. 530). Lefroy states that the amount of this fruit exported in 1871 was 672 tons. At present it is raised chiefly for local consumption.

Cape Gooseberry. (*Physalis Peruviana* L.=*edulis* Sims.)

Introduced from South Africa in 1874. It bears fruit abundantly, ripe in most months.

American Red Mulberry. (*Morus rubra* L.)

Cultivated frequently, but grows wild at Walsingham. Probably it is the native mulberry mentioned by the earliest settlers in 1612.

The Bermuda Company sent out seeds of mulberry in 1616, to raise the trees for feeding silk-worms. It is probable that they were of the White Mulberry (*M. alba* L.=*multicaulis* Per.), which still grows in Bermuda. But it has also been imported at other later periods; even as late as 1841, by Mr. Daniel Vaughan, according to Governor Lefroy, for feeding silk-worms.

The Bermuda Company also sent the seeds of the Black Mulberry in 1625. They spoke of them in a letter to Governor Woodhouse, as the seeds of "the greate black and best sort of mulberrye"; the fruit "very wholsome and goode."

There is no record of sending the American or Red Mulberry

In March, 1627, an act was passed by the Assembly requiring every owner or sharer of land to plant 50 mulberry trees on every share of land for three successive years. No mention is made of any importation of seeds at that time, so that they probably were to have been cuttings from those planted in 1616 Although some silk-worms were raised in that period, they were not of commercial importance.

Bread Fruit. (*Artocarpus incisa* L.)

Introduced at Mt. Langton by Governor Lefroy, in 1874, and appeared "likely to thrive." Native of the East Indies.

Jack Fruit. (*A. integrifolia* L.)

Cultivated at Par-la-Ville. A large East Indian tree, allied to the Bread-fruit, but with larger fruit and entire leaves. The seeds are edible when cooked.

Tamarind Plum. (*Chlorophora tinctoria* Don. = *Maclura xanthoxylon* Nutt.)

Cultivated in a few gardens in Paget Parish. Introduced, about 1865, from the West Indies. Fruit ripens in September.

The Osage Orange (*M. aurantiaca* Nutt.) is also occasionally cultivated for its large ornamental, but inedible, fruit. It was introduced from the southern United States in 1851, by Capt. Rollo, and has become naturalized in some places.

It would make excellent windbreaks if planted and pruned so as to form high hedges. It can easily be trained into thick hedges, 20 to 25 feet high, and would thus be very useful in exposed situations.

Date Palm. (*Phœnix dactylifera* L)

The Date can hardly be classed among the fruits of Bermuda, for the trees seldom ripen their fruit. Some of those at St. George's have, however, produced ripe fruits.

The Cocoa-nut Palm seldom matures fruit in Bermuda. (See under Shade and Ornamental Trees.)

28.—*Principal Introduced Shade Trees and Ornamental Shrubs.*

a.—Shade Trees and Ornamental Trees.

The following list is not intended to include every species now cultivated, but only those that are somewhat common, or else of some special interest.* Probably there are dozens of other species to be found in some of the larger private grounds which we had no opportunity to visit.

Large-flowered Magnolia. (*Magnolia grandiflora* L.)

A large and fine tree grows at the Penistons. Flowers in June. Introduced from the southern United States.

Tulip Tree. (*Liriodendron tulipifera* L.)

Not common. One good tree at Par-la-ville. Introduced from the United States.

Horse-radish Tree; Ben-oil Tree. (*Moringa pterygosperma* Gært.)

Not common. A tree with very much divided leaves. It produces the ben-oil of commerce, used by watch-makers. Native of the Old World.

Laurel. (*Pittosporum undulatum* Vent.)

Not uncommon. The white and fragrant flowers appear in March and April. Native of Australia.

One tree of *P. coriaceum* Dry. exists at Bishop's Lodge (Lefroy).

Sea-side Mahoe; False Gamboge Tree. (*Thespesia populnea* Cor.)

A malvaceous tree, known only at St. George's. Locally called "gamboge tree."

Silk Cotton-tree. (*Eriodendron anfractuosum* DC.=*Bombax ceiba* in Lefroy.)

Several trees at Mt. Langton were planted by Governor Reid, about 1845. Younger trees are found in other places. Native of India; naturalized in the West Indies and South America, where it grows to great size.

Sterculia Carthaginensis Cav.

A tree with very large palmate leaves. It occurs on the estate of Mr. Shaw Wood, at Spanish Point, in a very old garden.

* In the nomenclature of this and the following lists I have followed the Kew Catalogue (Index Kewensis), adding the names used by Lefroy, when different.

Bastard Cedar. (*Guazuma tomentosa* H. B. & K.)

St. George's, in the officer's garden (Lefroy) West Indian.

Melochia odorata L.

Occurs in Pembroke Marsh (Hemsley) A sterculiaceous tree from the East Indies.

French Cherry. (*Malphigia setosa* Speng.)

A large bushy tree standing by the officer's library at Prospect, north of the hospital (Lefroy). Also in other places.

Lignum-vitæ. (*Guaiacum officinale* L.)

Not common. Native of West Indies or Cape Good Hope.

Quassia. (*Quassia amara* L.) Mt. Langton. Planted in 1874.

Ailanthus Tree. (*Ailanthus glandulosa* Desf.)

Hamilton, chiefly about the public buildings. Native of China. First introduced by Governor Elliot (Lefroy).

Pride of India; Pride of China. (*Melia azedarach* L.)

Very common as a shade tree and by the road sides. The leaves are deciduous in mid-winter. The flowers appear before the leaves, February to April. Native of Central Asia; but introduced here from Charleston, S. C., about 1782, it is said. It is propagated very easily, but its timber is of little value.

Mahogany Tree. (*Swietenia mahagoni* L.)

The famous tree at the Flatts is the only one of large size. Introduced from the West Indies.

The Satin Wood was also planted at Mt. Langton by Governor Lefroy.

Loblolly Tree. (*Cupania paniculata* Camb. = *C. fulva* Mart.)

A single tree at Spanish Point, where it flowers freely in July (Lefroy). A sapindaceous tree, with pinnate leaves and arillate seeds; introduced from the West Indies.

Kœlreuteria paniculata Laxm.

Not common. Native of China. A small sapindaceous tree with pinnate leaves, yellow flowers, and inflated seed pods.

European Locust. (*Ceratonia siliqua* L.)

Not common; flowers in June. The trees are of different sexes and frequently only one sex is planted; thus they are often barren.

West Indian Locust. (*Hymenæa courbaril* L.)

A large, resinous timber-tree in the West Indies, with bilobed leaves; flowers white; legumes woody, containing a mealy pulp. This tree has been recorded by several writers, but is not in Lefroy's list. Whether it is now extinct here I do not know.

The former large locust tree, in Devonshire Parish, long ago fallen, under which the celebrated evangelist, George Whitefield, preached in 1748, is said to have been of this species. Its site was marked by a stone previous to 1850, according to Hurdis, in the grounds of the Cavendish House, near Hamilton.

Tamarind. (*Tamarindus Indica* L.)

Many very large trees occur. Lefroy mentions one at Point Shares 9½ feet in circumference and another at Brightwood of 14 feet. We saw one about 16 feet in circumference at Bailey Bay, in the grounds of Dr. T. A. Outerbridge. It must have been introduced very early, but I have found no record of the date. It produces fruit in abundance, but it is not utilized in Bermuda.

Bauhinia Vahlii Wight and Arn.

A white-flowered, ornamental leguminous tree at Mt. Langton. Flowers in June. Introduced in 1874, from Trinidad.

B. racemosa Lam. = *parviflora* Vahl. is also cultivated.

Cassia fistula L.

A leguminous tree, native of the East Indies and China, but naturalized in the West Indies. Flowers large, yellow, in drooping racemes; legumes long, cylindrical, containing a purgative pulp. Lefroy mentions a fine tree near the naval wells.

Cassia bacillaris L.

A tropical American tree, having pinnate leaves with only four leaflets; legumes often a foot long, warty. Mt. Langton (Lefroy).

Locust; Common Acacia. (*Robinia pseudacacia* L.)

Well grown trees occur at Hamilton, about the public buildings (Lefroy). Eastern United States; a valuable timber tree, with durable wood. Flowers white.

Poinciana. (*Poinciana regia* Boj.)

A very ornamental leguminous tree, native of Madagascar. Common in gardens, especially in the vicinity of Hamilton.

Locust; Bean Tree. (*Erythrina velutina* Willd.)

Probably introduced in the 17th century. Some very old and large trees are known; some of the largest have died within thirty years. Lefroy mentions one in Smith's Parish, on the land of Somers Tucker, which was twelve feet in circumference, six feet from the ground, with very prominent basal buttresses below that. The flowers, which appear in April, are orange.

Governor Lefroy thought that this was formerly called "yellow wood" or "yellow tree," though not the true Yellow-wood of the earliest settlers. He refers to a map of Ireland Island, dated 1694, on which a large "Yellow Tree" is located as a landmark near the site of the captain-superintendent's house. But it is more probable that this large tree of 1694 was a true Yellow-wood, for according to the depositions of 1693, that tree formerly grew on Ireland Island to a large size (See pp. 610, 616.)

Locust; Scarlet-bean Tree. (*Erythrina*, sp.)

A large handsome tree at Mt. Langton, similar to the last, but with dark scarlet flowers and scarlet seeds. The leaflets are more acute and farther apart, and the petioles larger (Lefroy). Flowers from February to April, partly before the leaves appear.

Sword Plant; Bois immortelle; Coral-bean Tree. (*Erythrina corallodendron* L. *and ? Erythrina speciosa* Andr.)

A very ornamental tree, commonly cultivated. It has clusters of bright scarlet flowers in spring, before the leaves appear. The seeds are scarlet with a black spot, and the wood is yellow. Introduced by R. R. Darrell, about 1825, from the West Indies

Occurs from Mexico to Brazil and throughout the West Indies.

Balsam of Peru Tree. (*Myroxylon peruiferum* L.)

A large ornamental tree at Mt. Langton and in other gardens. Introduced by Governor Reid, about 1845.

Gum Arabic Tree; Yellow Mimosa. (*Acacia Arabica* Willd.)

Frequently cultivated in gardens.

Black Ebony. (*Albizzia lebbek* Benth.=*Acacia lebbeck* Willd.)

Not uncommon. Lefroy mentioned one at the Penistons, 66 inches in circumference; we saw the same tree in 1898, when it was still thrifty. Flowers in July.

Demerara Almond; Almond Tree. (*Terminalia catappa* L.)

An ornamental combretaceous tree, native of Asia, but naturalized in the West Indies. The flowers are small, apetalous, in small axillary spikes, fruit compressed, winged on each side, 1.5 to 2 inches long; seeds edible, oily.

Several fine trees at Mt. Langton flowered in June (Lefroy).

Frangipani; Tree Jasmine. (*Plumeria rubra* L.)

A highly ornamental. low, deciduous tree, belonging to the Apocyneæ, and native of tropical America, from Mexico to Guiana; naturalized in the West Indies. It was introduced here a long time ago. Old trees exist in some of the earliest gardens. The abundant pink flowers appear in May, before the leaves.

White Cedar. (*Tabebuia pentaphylla* Hems.=*Tecoma pentaphylla* Juss.)

A highly ornamental tree of the *Bignonia*-family, commonly cultivated. Why it should have been called "White Cedar" is not obvious, unless the name refers to the appearance of the wood, but the bark is whitish.

The leaves are pinnate and covered with minute scales. The white or rose-colored flowers are 2 to 3 inches long, in clusters. It is a large timber tree in the West Indies; native of Panama.

Yellow Trumpet Flower; Tree Trumpet-flower. (*Tecoma stans* Juss.)

A very ornamental, small tree, 6–8 feet high. The trumpet-shaped yellow flowers are narrowly striped with purple; 1.5 to 2 inches long, in racemes. Native of the West Indies and Central America.

Calabash Tree. (*Crescentia cujete* L.)

This curious tree, which belongs to the *Bignonia*-family, was introduced very early. It is native of tropical America, Mexico to Brazil, and the West Indies.

From the hard, dry shell of the large fruit, useful vessels and utensils of various kinds are made here, as in other tropical countries, but perhaps the most important use to which they are put is

for making bailing dishes for boats. For this purpose it is only necessary to saw them into two equal parts. They are very durable for this use.

The tree itself is not a handsome one, for it usually grows in a rather straggling and irregular shape. The huge fruits, about the size and shape of a large football, distributed irregularly on the branches, give the tree a very curious appearance. The leaves are clustered.

There are many very old trees of this kind on the islands, some of which have been repeatedly bent and broken, or partly uprooted by former tempests, but having again taken root, some of them have become very picturesque. It seems to be very tenacious of life. The old tree at Walsingham, known as "Tom Moore's Calabash Tree," has been mentioned above (p. 440). It is not so large as many others and has lost some of its larger branches in severe tempests.

Fiddlewood Tree. (*Citharexylum quadrangulare* Jacq.)

PLATE LXX

This tree, which belongs to the *Verbena*-family (Verbenaceæ), has become thoroughly naturalized and is now the most common deciduous tree on the islands. It often grows wild in the cedar thickets, where its light green foliage contrasts strongly with the dark green of the cedar. It spreads both by means of its numerous seeds and by suckers from the spreading roots.

The first tree planted is said to have been the large one, about five feet in diameter, that stands in the lawn in front of the old house at Paynter's Vale; it was planted about 1830-32. (See plate lxx.) All others on the islands are believed to be descendants of this tree. It lost some of its larger branches in the great hurricane of Sept. 12, 1899. This tree is native of the West Indies and Guiana.

Sweet Bay Tree; True Laurel. (*Laurus nobilis* L.)

Not uncommon in old gardens. This is the classical laurel of the Old World.

India-rubber Tree (*Ficus elastica* Roxb)

This tree is said to have been introduced from South America in 1826. It is easily propagated and grows rapidly. Several large trees are notable, especially one near Flatts Village. The largest one in Hamilton, over 12 feet in circumference, blew down in the 1899 hurricane. Native of Asia.

Casuarina equisetifolia L.

A peculiar amentaceous tree, with fine branchlets and looking like the tamarisk, for which it is easily mistaken. There are no true leaves, but only leaf-sheaths on the slender branchlets. A few trees exist on Ireland Island, where it was once common (Lefroy).

The flowers are small, apetalous, in aments; the male aments are terminal. It is a native of the Old World, but naturalized in the West Indies.

Weeping Willow. (*Salix Babylonica* L.)

Common in moist soil. Introduced about 1830. Asiatic, but naturalized in most countries

Caraccas Willow. (*Salix Humboldtiana* Willd.)

The leaves are smooth, linear, serrate; catkins terminal, appearing with the leaves. Common in moist places. It grows rapidly. Native of the West Indies, and from Mexico to Brazil; Chili.

Otaheite Walnut. (*Aleurites triloba* Forst.)

Native of the East Indies, but naturalized in the West Indies. Common in gardens and also naturalized. The leaves are three-lobed, the middle lobe largest. The seeds are edible.

It belongs to the *Euphorbia* family, like the next two.

Otaheite Gooseberry. (*Phyllanthus distichus* Muell. = *Cicca disticha* L.)

One large tree at Mt. Langton flowers in May and June (Lefroy). Not common.

Perhaps not correctly identified by Lefroy, for this species, which is from the East Indies, but naturalized in the West Indies, is described as a *shrub* in the West Indies. The native West Indian species (*P. nobilis* Muell.) grows larger, as a "shrub or tree," and has a globose berry, and diœcious flowers, while *P. distichus* has monœcious flowers, and a depressed-globose, obtusely angled berry. Perhaps the large Mt. Langton tree belongs to some other of the numerous allied species. The sap of this plant is milky and poisonous, but the fruit is edible.

Sand-box Tree. (*Hura crepitans* L.)

A single large tree is in the Public Garden at St. George's (Lefroy). Elsewhere not common, though it grows readily. Its leaves are

deciduous, roundish, usually cordate, about 2 inches long; flowers appear in August. Its large fruit is very remarkable for its explosive power, when long dried. The sap is milky and poisonous. Native of the West Indies, south to Brazil.

Black Walnut. (*Juglans nigra* L.)

A few trees have been raised. Introduced from the United States.

Cycad; Sago Palm. (*Cycas revoluta* Thunb.)

Very common in gardens and borders. The largest seen had a trunk about seven feet high and over a foot in diameter. The plants are of separate sexes, and frequently only one sex is planted, so that seeds are not produced. Mr. G. W. West, of Shelly Bay, had a small

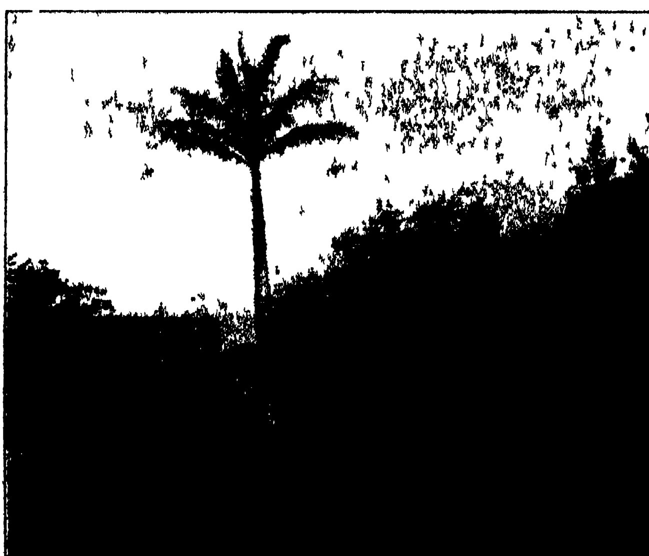

Figure 42.—Cycads, Royal Palm, Palmetto, etc. Two cycads (*C. revoluta*) stand in front of the royal palm.

plantation of them, with both sexes together, and here they produced an abundance of fertile fruit, like a nut, about an inch in diameter and covered with a red rind.

Mr. West at one time shipped large numbers of the leaves to New York for decorative purposes.

Mexican Bamboo. (*Bambusa vulgaris* Wendl.) See p. 427.

PLATE LXVII.

Large groups of bamboo are cultivated for ornament in many gardens and by roadsides, especially in the vicinity of Hamilton. The taller plants seen may be from 20 to 30 feet high. They are relatively slender and very graceful.

The following are the more common species of foreign cultivated palms:—

Royal Palm; Mountain Palm; Barbadoes Cabbage Palm. (*Oreodoxa oleracea* Mart.)

FIGURES 5, 42 PLATE LXVI, FIGURE 2

This is the tallest and most beautiful of the palms that have been cultivated here. Solitary specimens of good size occur in many grounds. Five tall trees that stand by the roadside, a short distance west of Hamilton, and near Crow Lane, are the best known examples. The trunk is remarkably smooth, hard, and symmetrical, looking almost as if turned in a lathe. The pinnate leaves are often 20 feet or more long.

This palm is native in the West Indies, where it sometimes grows to the height of 100 to 120 feet.

The true "Royal Palm" of the West Indies (*O. regia* Kth.) is similar, but the trunk is largest or swollen about midheight, and it does not grow so tall.

Gru-gru Palm; Grigri Palm. (*Astrocaryum aureum* Gr. & Wendl.)

Cultivated in a few places. Two of the largest are at Mt. Langton. The trunk, leaves, and spadix bear black prickles, those of the leaves about a quarter of an inch long. Native of the West Indies.

The name Gru-gru Palm is also applied in the West Indies to *Martinezia corallina* Mart., of Martinique, which bears bright red berries, about half an inch in diameter.

It is said that the name is given to these trees because the pith is infested by the very large, fat larva (gru-gru) of a boring beetle (*Calandra palmarum*), which is extracted and used as food by the natives, in the West Indies, who consider it a great delicacy.

Cocoa-nut Palm. (*Cocos nucifera* L.)

FIGURE 8.

Cultivated in many places, but seldom of large size. The fruit does not fully mature. In nearly all specimens the trunk is strongly

curved near the base. Naturalized in most tropical countries, but said to have been native of Panama.

Date Palm. (*Phœnix dactylifera* L.)

Cultivated in many grounds, but mostly as single trees. The trees are of different sexes, and as the two kinds are not often planted together, the fruit is seldom developed. Probably, also, the temperature is not, ordinarily, high enough to ripen the fruit well, for the date matures best in the hottest and driest climates.

There is a good specimen of this palm by the side of the old Walsingham house. A large one in the public garden at St. George's sometimes matures its fruit. Native of oriental countries but naturalized in the West Indies.

Catechu Palm. (*Areca catechu* L.) Not common. Mt. Langton.

Japanese Palm. (*Rhapis flabelliformis* L.)

A small palm commonly cultivated in gardens.

Several other palms are occasionally cultivated.

Screw Pines. (*Pandanus utilis* Bory; *P. Veitchi* Hort.; *P. ordoratissimus* L.)

These and other species are found in a few gardens.

b.—Principal Introduced Ornamental Shrubs; Hedge Plants.

The ornamental shrubs are very numerous and many are cultivated only in a few grounds. The following are those of most importance, aside from those that bear fruit.

Galba. (*Calopyllum calaba* L., Jacq.) See p. 483.

Not uncommon in hedges and borders.

St. John's Wort; St. Andrew's Cross. (*Ascyrum hypericoides* L. = *A. crux-andreæ* L. in Lefroy.)

A low, straggling, tropical American shrub, 1 to 2 feet high, with small, blunt, subsessile, stipulate, and punctate leaves. Flowers yellow, pedicelled; sepals 6; petals 4. Probably native; perhaps introduced. Pembroke Marsh and moist places elsewhere.

Hibiscus. (*Hibiscus Rosa-Sinensis* L.; *H. grandiflorus* Mich.; *H. Bancroftianus* Macf.; *H. mutabilis* L.)

These and others are cultivated for ornament. The red flowers of the second are often 6 inches or more in diameter. The Okra (*Hibiscus esculentus* L.) is sometimes raised as a vegetable.

Martinique Laurel. (*Murraya exotica* L)

Cultivated frequently; a highly ornamental shrub of the *Citrus*-family. East Indian.

Wampee. (*Clausena excavata* Burm. = *Cookia punctata* Retz.)

An ornamental East Indian shrub; not common.

Lime Myrtle; Dwarf Orange. (*Triphasia aurantiola* Lour. = *T. trifoliata* DC.)

A small East Indian shrub, sometimes used as a hedge-plant.

American Holly; South-sea Tea; Box. (*Ilex cassine* Walt.)

Common in some parts of the islands, as near Flatts Village. Valued for Christmas decorations. The English Holly (*I. aquifolium*) is sometimes cultivated.

Euonymus Japonicus L. Common.

Flower Pride; Barbadoes Pride. (*Cæsalpinia pulcherrima* Sw.)

An East Indian leguminous shrub, early naturalized in the West Indies. The flowers, which are orange or orange-red, appear in August.

Pigeon Pea; No-eye Pea. (*Cajunus Indicus* Spr.)

An oriental shrub, 8 to 10 feet high, early naturalized in the West Indies; flowers yellow or orange. The seed is edible.

Furze; Gorse; Whinn. (*Ulex Europæus* L.)

This has been raised from seed in large quantities, but does not appear to become permanently naturalized. It was first introduced by Matthew Jones, about 1874 or 5, and flowered freely for a few years.

West Indian Ash. (*Cassia glauca* Lam.)

A shrub or small tree with large yellow flowers, cultivated in a few gardens. Native of East Indies.

Lead Bush. (*Leucæna glauca* Benth.)

A very common Acacia-like shrub with bipinnate leaves, native of tropical America, naturalized in Bermuda, or perhaps native. The flowers are white, in globose clusters. Seeds itself freely and is liable to become a troublesome weed.

Acacia paniculata W., recorded only by Jones, is a half-climbing shrub with yellow flowers.

Napoleon's Plume. (*Bauhinia porrecta* Sw.) Not uncommon.

A handsome shrub with bilobed leaves; flowers in terminal racemes, variegated with rose and white.

Spiræa salicifolia L.; *S. prunifolia* Sieb.

These and other species of *Spiræa* are often cultivated.

Wild White Rose. (*Rosa lævigata*? Mich.)

Naturalized or native. Walsingham and Pembroke Marsh.

Numerous species and varieties of garden roses are common in cultivation. White roses are among the most abundant.

Deutzia. (*D. scabra* Th.) Not uncommon.

Tamarix; Spruce. (*Tamarix Gallica* L.) See p. 433.

A tall shrub, native of southern Europe, extensively used for windbreaks and hedges, especially near the shores.

Crape Myrtle; Queen of Shrubs. (*Lagerstrœmia Indica* L.)

A very beautiful shrub or small tree, native of China. Common in the larger gardens.

Laurestinus. (*Viburnum tinus* L.)

Abundant at Mt. Langton, flowering in most months.

Elder. (*Sambucus nigra* L.)

Native ?. Not very common; in waste places.

Cape Jasmine. (*Gardenia jasminoides* Ellis = *G. florida* L.)

This and other species of *Gardenia* are cultivated in some gardens.

Scolosanthus Sugræanus Griseb. On Pagets Beach (Millspaugh).

Red Jasmine. (*Ixora coccinea* L.) Often seen in gardens. Other species of *Ixora* are also cultivated.

Privet. (*Ligustrum vulgare* L.) Not common.

Oleander. (*Nerium oleander* L.) See p. 426.

Naturalized. Very abundant, and used extensively for hedges and windbreaks by the roadsides and elsewhere; sometimes found on the sand dunes, at a little distance from the sea. Stands salt winds fairly well, though the foliage is often damaged. Flowers from May to September. A white-flowered variety is also common. Said to have been introduced about 1790.

French Trumpet Flower. (*Thevetia nereifolia* Juss. or *Thevetia thevetia* L.)

A handsome shrub, with glossy, linear leaves, 4 to 5 inches long; flowers large, saffron-colored. Common; partially naturalized.

Snuff Plant. (*Buddleja Americana* L.)

An American, introduced loganiaceous shrub, common in some places along the roadsides near Hamilton. It has terminal clusters of small yellow flowers. Hemsley also records *B. Madagascariensis* Lam.

Spanish Pepper; Red Pepper. (*Capsicum frutescens* L.)

Common in gardens and borders. The berry is elongated-conical. Probably native, for the early writers refer to a plant that agrees well with this. Governor Moore, 1612, speaks of peppers growing wild. Governor Butler, 1621, sent "Red-peppers" to Virginia; and Capt. Smith, 1624, speaks of a fruit like a barberry that "sets all the mouth on an extreme heat, very terrible for the time," and hence called "red pepper."

Hurdis, p. 370, mentioned also the Bird Pepper (*C. baccatum*) as cultivated, but we did not see it. It has a small globose or ovoid berry.

The Guinea Pepper or Chillies (*C. annuum* L.) is also cultivated.

Common Sage; Sage Bush. (*Lantana involucrata* L. = *L. odorata* L.) See p. 432.

Thoroughly naturalized, forming the underbrush over extensive tracts, and growing in the most barren and rocky soils, or even in

crevices of ledges. In many places a troublesome weed. Said to have been introduced in the latter part of the 18th century by Col. Spofforth, to furnish fuel. It is very useful on the sand dunes in arresting the drifting sands. (See pp. 475–6.) The flowers, which are pale lilac, are abundant at most seasons. The stems are not prickly.

Red Sage; Red-flowered Sage Bush. (*Lantana camara* L.)

Naturalized and common in most places. Native of tropical America and West Indies, but said to have been brought here from Madeira, about 1810. The flowers are light orange-red.

Prickly Sage Bush; Yellow-flowered Sage. (*Lantana crocea* Jacq.)

Naturalized and common, but less abundant than the others. The flowers are light orange-yellow.

Pigeon Berry. (*Duranta Plumieri* Jacq.)

A common, naturalized, tropical American shrub, of the *Verbena*-family, with blue flowers in racemes. The plant is not prickly; leaves smooth, glossy; berries yellow, wax-like, poisonous.

It is allied to the native Turkey Berry (*Callicarpa ferruginea*), a shrub which has bluish white flowers and bears large clusters of round, red or magenta berries.

Prickly Myrtle. (*Clerodendron aculeatum* Gr.)

A tropical American shrub, allied to the last, naturalized on Ireland Island and elsewhere. It has white flowers, about half an inch long, with exsert purple stamens.

Another species (*C. capitatum* = ? *Whitfieldi* Seem. ?) was found as a naturalized plant about the Pembroke Workhouse, by Lefroy.

Cassava; Cassada; Tapioca-plant. (*Manihot utilissima* Pohl. = *Janipha manihot* Kth.) See p. 525.

Introduced about 1616, and still cultivated. A tuberous rooted euphorbiaceous shrub, with a milky poisonous sap, but yielding a large amount of starchy food from the roots, by special preparation (tapioca, etc.). Native of tropical South America, but early naturalized in the West Indies.

Coral Plant. (*Jatropha multifida* L.)

Commonly cultivated in flower gardens. Native of South America. Other species are cultivated less frequently, as *J. podagrica* Hook. and *J. hastata* Jacq.

Slipper Plant; Arsenic Plant. (*Pedilanthus tithymaloides* Poit.)

Leaves thick, fleshy, alternate, bright green; involucre red. A poisonous West Indian shrub, often cultivated for its bright green foliage.

Euphorbia candelabrum Trem.

The large and fine specimen grown at Bishop's Lodge is the parent of most of those cultivated on the islands.

Spanish Bayonet. (*Yucca aloifolia* L. = *Y. serrulata* Haw.)

Common in hedges and by roadsides; sends up tall stalks, 10 to 12 feet high, with spikes of white flowers, in May and June.

Other species, including *Y. filamentosa* and *Y. Whippleyi*, are cultivated occasionally.

Bitter Aloe; Barbadoes Aloe. (*Aloe vera* L. = *Aloe vulgaris* Lam.)

Formerly cultivated to a considerable extent for the commercial drug aloes. The collection of the drug is said to have proved unhealthful, and sometimes fatal, so that it was abandoned.

Very common and quite naturalized. Flower-scapes 2 to 3 feet high; flowers yellow, in racemes.

Giant Aloe. (*Furcræa gigantea* Vent. = *Fourcroya gigantea*, in Lefroy.)

A large West Indian species, often cultivated. The fleshy leaves are entire, mucronate, arising from the top of a short, thick trunk; flower-scapes 20 to 30 feet high, branched; the flowers racemose, greenish white.

Century Plant; Margay; Golden Aloe. (*Agave Americana* L.)

Numerous large plants were seen in old gardens and borders. The branched flower-scape is sometimes 20 to 30 feet high, and bears in early spring large numbers of yellow flowers, clustered at the ends of the branches. The stalks, when dry, are often locally called "bamboo."

Several other species are cultivated, as the Blue Aloe (*A. Mexicana* Lam.); *A. var. variegata* Hort.; *A. striata* Z.; *A. xylonacantha* Salm.

These woody endogenous plants, though not real shrubs, are put here for convenience.

c.—The more prominent Climbing Plants or Vines.

Several fruit-bearing vines have been included in a previous list (*a*) with the fruit trees. Among these are the Passion-flowers, the Grape, etc. Others are included in the list of seaside plants.

The following list comprises the more important naturalized and cultivated species, and some natives, but many others are cultivated in the larger gardens.

Sweet Clematis. (*Clematis flammula* L.)

Grows luxuriantly in some places; cultivated. European.

Japan Clematis. (*C. Japonica* Thunb.)

Several varieties of this fine species are cultivated in some gardens.

Woodbine; Virginia Creeper; False Sarsaparilla. (*Vitis hederacea* Ehr. = *Ampelopsis quinquefolia* Mich)

This common North American vine, which is native about Walsingham, is often cultivated.

Japanese Ivy. (*Vitis inconstans* Miq. = *Ampelopsis tricuspidata* Sieb.; *tridentata* Thun.; *Veitchi* Hort.)

Cultivated in gardens, for covering walls.

Poison Ivy; Poison Vine. (*Rhus toxicodendron* L.)

Native and very common in thickets and swamps Described by the earliest writers with correct accounts of its poisonous qualities and its variable effects on different individuals.* Leaves trifoliate, flowers greenish, fruit green, in loose clusters; the sap is not milky. Adheres to trees and walls, like the true ivy, by root-like tendrils. It is liable to be mistaken for the Japan Ivy, some varieties of the latter resembling it in foliage and habit.

* A solution of sugar of lead (lead acetate) in weak alcohol is one of the best remedies for the irritating poison of this plant; but zinc sulphate and copper sulphate are, perhaps, equally useful, and safer to use. The poison is an oil, allied to croton oil. Dry heat is also useful. The powder of bismuth subnitrate is useful to allay the itching.

Passiflora suberosa L.(= *P. minima* L.) Pagets (Millspaugh).

American Wistaria. (*Wistaria speciosa* Nutt. = *N. frutescens* Poir.)

Cultivated locally. The Japanese species is also cultivated.

Blue Pea. (*Clitoria ternatea* L.)

This and other species of the genus are cultivated and partly naturalized. The flowers are very ornamental.

Christmas Bush; Styver Bush. (*Cassia bicapsularis* L.)

A naturalized vine, common in hedges.

English Ivy. (*Hedera helix* L.)

Frequently cultivated, but does not grow so freely as in Europe.

European Honeysuckle. (*Lonicera caprifolium* L.)

This and other allied species, as *L. sempervirens* and *L. Japonica*, are cultivated, but in most cases do not grow very freely.

Wild White Jasmine (*Jasminum simplicifolium* Forst. = *gracile* Andr.) (See p. 441.)

Naturalized at Walsingham, where it grows luxuriantly, forming a dense tangle, covering the rocks and large trees; introduced here about 1840, by Archdeacon Spenser. Flowers May to June.

Yellow Jasmine (*J. fruticans* L.); White heart-leaved or Arabian Jasmine (*J. sambac* Ait.); pinnate-leaved, white European Jasmine (*J. officinale* L.).

These are all naturalized, but less abundantly than the first.

Blue-flowered or Common Morning Glory. (*Ipomœa hederacea* Jacq. = *I. nil* Roth.)

Very common, often climbing to the tops of high trees in moist grounds; naturalized, or perhaps native. The most abundant species.

Purple Morning Glory. (*I. purpurea* Roth)

Naturalized; perhaps native at Walsingham; abundant at "Convolvulus Cave."

Ipomœa sidæfolia Chois. Naturalized. Flowers white, sweet scented; leaves entire, cordate. Mexican.

Noyau Vine. (*I. dissecta* Willd.)

Partly naturalized; common. Leaves palmate; flowers white, purplish at base, sweet scented.

Yellow-flowered Morning Glory. (*I. tuberosa* L.)

St. George's, in the Public Garden

Arrow-leaved Morning Glory. (*I. sagittata* Poir.)

Naturalized in a swamp at Shelly Bay; a North American plant.

Ipomœa villosa R. and P., with the preceding near the sea; perhaps native. Flowers dark purple, variegated. Several other species occur, as *I. Leari*; *I. acuminata* R. and S.; *I. Jamaicensis* Don.

Ipomœa triloba L., near Hamilton (Millspaugh).

Cypress Vine. (*Ipomœa* or *Quamoclit coccinea* L., and *I* or *Q. quamoclit* L. = *vulgaris* Chois.)

Both are naturalized and common; the former more abundant.

Sweet Potato. (*Ipomœa batatas* Poir., or *Batatas edulis* Chois.) See pp. 525, 532.

Extensively cultivated, since 1616

Convolvulus Jamaicensis Jacq. Probably native; found near the sea. Flowers pale purple or white, one-half an inch long; leaves entire, narrow lanceolate.

Dichondra repens Forst. Pastures and marshes; native.

Matrimony Vine. (*Lycium vulgare* Dun.)

Naturalized from Europe; will grow close to the shores.

Maurandia. (*M. semperflorens* Jacq.)

Naturalized and common. *M. Barclayana* Bot. is also cultivated.

Maurandia (or *Lophospermum*) *erubescens* Don. Common in gardens.

Red Trumpet Flower. (*Tecoma radicans* Juss.)

Common as a cultivated vine. The orange-flowered species (*T. Capensis* Lind.) is also cultivated.

Bougainvillæa spectabilis Willd.

A very ornamental garden plant, in flower from November to May. Common in the larger gardens. Brazilian; introduced from Gibraltar in 1874, by Governor Lefroy.

Another species (*B. glabra*) has also been cultivated at Clarence House (Lefroy).

Madeira Vine. (*Boussingaultia baselloides* H. B. K.)

Occasionally cultivated; South American.

Dutchman's Pipe; Juaco. (*Aristolochia trilobata* L.) Not common.

Oriental Smilax; Sarsaparilla. (*Smilax aspera* L. = *S. sagittæfolia* Lodd.)

Naturalized in some places. Not common.

29.—*The Extermination or partial Extermination of Native Birds.*

a.—Character of the Original Native Avifauna.

Fortunately several of the early writers* give pretty full accounts of the birds that they found on the islands, and especially of those seabirds that existed in large numbers and were of great importance to them as food.

These writers all agree in respect to the wonderful abundance of certain seabirds, whose eggs and flesh contributed very largely to their food supply during the early years. Indeed, it is probable that without this source of food those shipwrecked parties would have died of starvation. Even later, in 1614–1615, during the famine that occurred among the settlers (see p. 552), the birds furnished for a time a large part of their food. One of these abundant and useful birds they called the 'Egg-bird,' because its spotted eggs were laid in vast numbers in May, openly, on some of the smaller sandy islands 'reserved for their use.' These were undoubtedly terns. They were very soon all exterminated or driven away.

Among the formerly abundant birds there was one of very great interest; originally called the 'Cahow' or 'Cohowe,' with various

* Strachy and Silvanus Jourdan, of Somers' shipwrecked party, published good accounts in 1610. Governor Moore's letter was written in 1612, but it was not published at that time. The Rev. Lewis Hughes published his account in 1615, and Capt. John Smith, borrowing his facts mainly from Governor Butler's MSS. Historye, published his own History in 1624.

other spellings, from its singular note. This bird is unknown to science and is, so far as known, totally extinct, for it disappeared within the first twelve years of the settlement.

Among the other seabirds of less importance recorded as breeding were the Tropic Bird and the "Pimlico" (Shearwater=*Puffinus*), both of which probably continue to breed here, though the latter exists now only in small numbers, if at all.

Of the wading birds, the White Heron attracted particular attention and was the subject of an early protective law. It bred so abundantly that a locality, "Hearn Bay" (originally White Hearn Bay) on Great Sound, took its name from this heronry.

Of land birds a considerable number were mentioned, especially by Governor Butler, who distinguished part of them as merely migrants.*

The "Crow," referred to by Governor Butler as flying out to sea about sunset, was doubtless the true American Crow, and if so it had been more numerous at first. It is still found in Bermuda, though bounties have been unwisely offered for its destruction. The bird compared to a crow by Governor Moore, 1612, which has been thought to be the Catbird, from his description of its manners, may have been the real crow. The following extracts give about all of value that is recorded by these early writers concerning the resident land birds, and some others that they noticed as migrants.

William Strachy, in his narrative, 1610, has the following account: "Fowle there is in great store, small Birds, Sparrowes,† fat and plump like a Bunting, bigger than ours, Robins of divers colours, greene and yellow,‡ ordinary and familiar in our Cabbins, and other of lesse sort.§ White and gray Hernshawes [herons], Bitters [bit-

* The following 12 species of birds, generally considered native, apparently still breed on the islands, though some are in very small numbers: Catbird; Cardinal Bird; Blue Bird; White-eyed Vireo; American Crow; Kingfisher, Ground Dove; Florida Gallinule; Blue Heron (rarely); White Heron (rarely); Tropic Bird (abundantly); Audubon's Shearwater or "pimlico" (perhaps rarely) It is doubtful whether the Ground Dove was not introduced from the Bahamas. Besides these, at least seven species introduced by man are now resident, among them the American Quail; English Sparrow; European Goldfinch; Wheatear; Mocking Bird, etc. Over 175 species of migrants visit the islands more or less frequently.

† This probably applies to the Cardinal Bird, whose female and young would, to a casual observer, resemble a large fat bunting.

‡ This probably refers to the Bluebird, whose male and female differ in color. But the author, writing from memory, must have become hazy as to the colors.

§ The common native White-eyed Vireo might have been intended here.

terns], Teale, Snites [snipes], Crowes, and Hawkes, of which in March wee found divers kinds Ayres, Goshawkes and Tassells, Oxen birds, Cormorants, Bald-cootes, Moore Hennes,* Owles, and Battes in great store. And upon New-yeeres day, in the morning, our Governour being walked forth with another Gentleman, Master James Swift, each of them with their Peeces killed a wild Swanne,† in a great Sea-water Bay or Pond [Mullet Bay?] in our Iland."

The Rev. Lewis Hughes, 1615, gives the following item as to the song birds:

"The birds make a noise almost all night, but not with such pleasant tunes as the Larkes, and other birds doe in England, Heere is no bird that singeth in the daie but the sparrow,‡ the Robin redbrest§ & the Robin-williams."‖

The following description of one of the birds by Governor Moore has been supposed by Lefroy and others, but without sufficient reason, to apply to the Catbird, which is still very common, and audacious, and as noisy as with us:

"Fowles there are of divers sorts, but amongst all there is a bird like unto yours, which you call in England a Crow, which though they talke in the Barmuda language, yet their tongues shall walke as faste as any English womans: wee cannot goe up into the woods, but that they will follow after us with such an outcry that it would fret a man to heare them. They are very good meate, fat, and as white flesh as a chicken. We many times make some of them leave their talking with stones or cudgels, for they will sit and face you hard at your hand."¶

Capt. John Smith, in describing the fatal disease or famine of 1614–15 (see p. 552), mentioned the appearance of birds that he

* Probably the Florida gallinule, which still breeds here in small numbers.

† The American Swan (*Olor Columbianus*) has been taken in modern times.

‡ Probably the Cardinal Bird.

§ The Bluebird, without doubt.

‖ There is no direct clue as to the species intended by this name, but if it be a native singing bird, still resident here, it is probably the White-eyed Vireo,—the only other common, resident, native singing bird, except the Catbird.

¶ Governor Moore must have been familiar with the English crow. Therefore it is quite probable that these were real crows, for Governor Butler also speaks of the extreme tameness and audacity of the crows when the islands were first visited. I have personally seen them, especially in the breeding season, very tame, noisy, and fearless on some of the small, distant and seldom visited islands off the American coast. The flesh of young crows is said to be palatable.

called "Ravens." There can scarcely be a doubt but that they were Turkey Buzzards. These birds, like other vultures, have often been observed to appear during the time of fatal epidemics in other places. During the epidemic of yellow fever in Bermuda, in 1853, a specimen of the Turkey Buzzard was shot and examined by Mr. Hurdis. Capt. Smith's account is as follows:

"About this time or immediately before, came in a company of Ravens, which continued amongst them all the time of this mortality and then departed, which for any-thing knowne, neither before nor since, were ever seene or heard of; this with divers other reasons caused Master More to goe out to Sea, to see if he could discover any other Islands, but he went not farre ere ill weather forced him backe; and it were a noble adventure of him would undertake to make more perfect all the dangers are about the Summer Iles."

Figure 48.—Turkey Buzzard (*Cathartes aura*).

I have seen no record of this bird appearing in Bermuda since 1853, but probably it flies near the islands not infrequently, without attracting attention.

None of the early writers mention any birds corresponding to the Ground Dove or the Quail, both of which are common and familiar. Therefore it is probable that they were introduced in later times. (See ch. 34.)

Nor do those quoted above mention a parrot. But this would not be strange, in case a species of shy and retiring habits had existed.

Governor Roger Wood, in a letter written about 1632, refers to four parrots that his wife was sending by the ship to a friend in England, as follows:

"My wiffe hath sent 4 Parrats in a cage unto my Lady, to bee either kept for your Honor's pleasure to looke upon, or to give unto who your Honor please who takes delight in keeping of them. The

parrat is a finne bird, and yellow upon the head and necke*—she desyres my Lady to accept it in as good part as she in all love and duty doth tender the same."

Although it is not definitely stated that these were native Bermuda birds, the manner in which they are described would rather imply that they were so regarded. It is, indeed, quite possible that some species of parroquet did breed there at that time. An aged citizen told me that he once saw a pair of green birds fly out from a hole in a South shore cliff, where they seemed to have a nest. According to his account they looked much like parrots. Of course, it is also possible that parrots escaped from cages or liberated from vessels may have bred here, without becoming permanent residents.

Governor Butler, in his Historye of the Bermudaes (pp. 3, 4, 5), gives the following account of the native birds: "Neither hath the ayre for her part bin wantinge with due supplies of many sortes of foules; as the graye and greene plover; some ducks, and mallards, red-pshancks [red-shanks], sea-wigeons, graye bitturnes, cormorants, the white and graye herne, great store of sparrowes and robins (which have lately bin destroyed by the cats), woodpeckers, very many crowes† (who for a while overboldly wonderinge at the newe sight of man) many of them findinge the cost of their curiositie, the rest are now flowne away and seldom seene, only some few are sometimes found in the most solitary partes from whence, notwithstandinge, they are generally observed to take their flight to se, about the sunnes settinge, allwayes directinge their course to the north-west; whence many (not improbably) conjecture that some unknowen iland lieth out that waye; nott farr of here are also, sometimes of the yeare, faulcons, and farfaulcons, osprayes, and a smale kind of hawke, in shape and plume like a sparrow-hawke, but larger winged, and hoofers for her praye, like a caystrell,‡ but thes being but seldome found, are (justly) thought to be only passengers. But above all thes, most deserving observation and respect are thoes two sortes of birdes the one (from the tune of his voice), the other (from the effect) called the cahowe and egge-bird."

* This peculiarity of a yellow head and neck would indicate that these birds were Carolina parroquets (*Conurus Carolinensis*), or a closely related extinct species. This is the only existing American species having that character strongly marked.

† This must have been the American Crow (*Corvus Americanus*), or the Fish Crow (*C. ossifraga* Wils.). Perhaps both were native here

‡ Probably the American Pigeon Hawk, a migrant still.

b.—The Egg Birds (*Sterna*, sev. sp.).

Under the name of "Egg Birds," the early writers included all the species of terns that were breeding, of which there may have been several. Hughes designated two kinds, viz: "Sandie Birds and Noddies."

The numbers of the Egg Birds originally breeding on some of the smaller islands must have been exceedingly great. But owing to the reckless and heartless manner in which they were destroyed, with their eggs and young, it took but a few years to exterminate them, or so nearly so that they ceased to breed in any noticeable numbers, and only on the most inaccessible rocks.

They are now known only as migrants As breeding birds they have long been extinct at the Bermudas, the last records of their breeding, even in small numbers, being about fifty years ago.

Capt. John Smith, in the 1829 edition of his History, says that both the egg birds and the cahows were even then "all gone."

William Strachy, of Somers' party, described them in 1610:

"There is fowle in great number upon the Ilands, where they breed, that there hath beene taken in two or three houres, a thousand at the least: the bird being of the bignes of a good Pidgeon, and layeth egges as big as Hen egges upon the sand, where they come and lay them dayly, although men sit downe amongst them: that there hath beene taken up in one morning by Sir Thomas Gates' men one thousand of Egges: and Sir George Sommers' men, coming a little distance of time after them, have stayed there whilst they came and layed their eggs amongst them, that they brought away as many more with them; with many young birds very fat and sweet."

The Rev. Lewis Hughes, who recognized two kinds of egg birds, noticed the regularity with which these and the Cahow returned each year. He says:

"When the Cahouze time is out, other birds called noddies and sandie birds come in, and continue till the latter end of August."

Governor Moore, in 1612, gives the following graphic account of the abundance of the Egg Birds at that date:

"And for fowle wee went the third day of our arrival unto the Bird Ilands* (as we call them) and using neither sticke nor stone, bowe nor gunne wee tooke them up in our hands so many as we

* One of these was undoubtedly Long Bird Island. They probably bred also on Cooper's Island, Charles Island, Castle Island, and several other small islands where there was sandy soil.

would, that every one of the company were to have, some three some foure a peese, three for a childe boy or girl, for a man foure, then reckon what those that served some fourscore people did amount unto. But this is certaine, if wee would have brought away twice so many more wee might, but our order is not to take Fish or Fowle but for one or two meales, because that by reason of the flies, and heat of the countrey they will not keepe, especially these two monthes, June and July, and some part of August."

Governor Butler, writing of the Egg Birds in 1619, said:

"Thes last, arriveinge the first of the spring, upon the first of May,* a day constant kept, falls a layeinge infinite store of egges, upon certaine smale sandy ilands reserved for them; and so continue all that monethe, being all the while so tame and fearlesse that they suffer themselves, with much adoe, to be thrust of their egges, the which, notwithstandinge they laye and sitt upon promiscuously; so that many thousands of egges (being as bigge as hen's egges) are yearely eaten, and many more would be, but that by stricte inhibition, they are preserved."

This was written after certain restrictive laws had been passed, against recklessly killing and robbing these birds and the Cahow, but "overlate," as Butler himself said. (See p. 673.)

From the early accounts it is not possible to tell, with certainty, which species of terns were included under the general name of Egg Birds.

Hughes speaks of two kinds: the Noddies, which were probably the same as the West Indian Noddy† (*Anous stolidus*), and the Sandies, which may have been the Common Tern (*Sterna hirundo*) and the Roseate Tern (*Sterna Dougalli*), both of which are recorded by Hurdis as having been found breeding on Gurnet Head Rock in some numbers (40 to 50 pairs), in 1848, but were destroyed or driven away soon after that, so that for about fifty years past they have only been known as irregular migrants, not seen at all some years, but sometimes appearing in flocks of considerable size in autumn.

. . . . .

* This being "old style" reckoning, the corresponding date now would be May 12th. This is about the date when they now arrive at Nantucket Island, where they still breed.

† Hughes and the other early historians of Bermuda probably obtained their names of the birds and fishes, etc., directly from the sailors, some of whom had doubtless visited the West Indies in former voyages. It is well known that the vernacular or sailor's names of West Indian productions are wonderfully persistent, large numbers of them being widely used now, just as they were 300 years or more ago.

The Noddy, during the past fifty years, has only been observed as a very rare accidental visitant.

But it is possible that the original Egg Birds may have included other species that are now confined to the West Indies and other southern waters, in the breeding season, for they were only summer visitors in Bermuda The large size of the eggs (equal to a hen's egg) might indicate the larger tern (*Sterna maxima*), which still breeds in the Bahamas. The *Sterna anosthætus*, which breeds in the Bahamas, may also have been included.

c.—*The Cahow; its History and Extermination.*

The most interesting as well as most important native bird, when the islands were first settled, was called the Cahow, from its note. It bred in almost incredible numbers on some of the smaller islands near St. George's and Castle Harbor, especially on Cooper's Island. It was nocturnal in its habits and was readily called by making loud vocal sounds, and then easily captured by hand, at night. Its flesh was described as of good flavor, and its eggs were highly prized as food. As it came to land and bred in the early part of the winter, when no other birds or eggs were available, it was quickly exterminated for food by the reckless colonists.

It laid a single, large, white egg, described as like a hen's egg in size, color, and flavor. The nest, according to the earliest writers, was a burrow in the sand like a coney's, and *not* in crevices of the rocks, like that of the shearwaters, with which many writers have tried to identify it. Governor Butler, in his 'Historye of the Bermudaes,' alone stated that its eggs and young were found in crevices of the ledges, but he evidently did not have the advantage of personal experience, for at that time the bird was probably extinct, or very nearly so.

The time of laying its eggs is a very remarkable point, in which it differed from all other birds of northern latitudes. The early contemporary writers all agree that it laid its egg 'in December or January' or 'in the coldest and darkest months of the year.' The shearwaters, even in the West Indies, lay their eggs in spring (March and April) and their eggs are so musky that they are not edible; certainly no one would compare them to a hen's egg. Their flesh also has so strong a flavor of bad fish-oil and musk that no one would eat it, unless on the verge of starvation; though the newly hatched young are sometimes eaten by sailors for lack of anything better.

The bird itself was variously described as of the size of a pigeon, green plover, or sea mew; its bill was hooked and strong, and it could bite viciously; its back was 'russet brown' and there were russet and white quillfeathers in its wings; its belly was white. It arrived in October and remained until the first of June.

There is no known living bird that agrees with it in these several characters. Most certainly it could not have been a shearwater, as Hurdis and others have supposed, nor any known member of the petrel family, all of which have such a disagreeable flavor that neither their flesh nor eggs are used as food unless in cases of starvation.

The following graphic account of the bird and its habits was written by Mr. W. Strachy, one of the party wrecked with Sir George Somers in the 'Sea Venture,' July, 1609:

"A kinde of webbe-footed Fowle there is, of the bignesse of an English greene Plover, or Sea-Meawe, which all the Summer we saw not, and in the darkest nights of November and December (for in the night they onely feed) they would come forth, but not flye farre from home, and hovering in the ayre, and over the Sea, made a strange hollow and harsh howling. They call it of the cry which it maketh, a Cohow. Their colour is inclining to Russet, with white bellies, as are likewise the long feathers of their wings, Russet and White, these gather themselves together and breed in those Ilands which are high, and so farre alone into the Sea, that the Wilde Hogges cannot swimme over them, and there in the ground they have their Burrowes, like Conyes in a Warren, and so brought in the loose Mould, though not so deepe; which Birds with a light bough in a darke night (as in our Lowbelling) wee caught, I have beene at the taking of three hundred in an houre, and wee might have laden our Boates. Our men found a prettie way to take them, which was by standing on the Rockes or Sands by the Sea-side, and hollowing, laughing, and making the strangest outcry that possibly they could; with the noyse whereof the Birds would come flocking to that place, and settle upon the very armes and head of him that so cried, and still creepe neerer and neerer, answering the noyse themselves; by which our men would weigh them with their hand, and which weighed heaviest they took for the best and let the others alone, and so our men would take twentie dozen in two houres of the chiefest of them; and they were a good and well relished Fowle, fat and full as a Partridge. In January wee had great store of their Egges, which are as great as an Hennes Egge, and so fashioned and white

shelled and have no difference in yolke nor white from an Hennes Egge. There are thousands of these Birds, and two or three Ilands full of their Burrows, whether at any time (in two houres warning) we could send our Cockboat, and bring home as many as would serve the whole Company: which Birds for their blindnesse (for they see weakly in the day) and for their cry and whooting, wee called the Sea Owle;* they will bite cruelly with their crooked Bills."

The following description is taken from 'The Narrative' (1610), by Silvanus Jourdan, who was also one of Somers' party:

"Another Sea fowle there is that lyeth in little holes in the ground, like unto Coney holes, and are in great numbers, exceedingly good meate, very fat and sweet (those we had in the winter) and their eggs are white, and of that bignesse that they are not to be knowne from these egges. The other birds egges [terns] are speckled and of a different colour."

In "A Letter written from the Summer Islands," Dec., 1614, by the Rev. Lewis Hughes, the following account of the cahow occurs:

"Here is also plenty of sea foules, at one time of the yeare, as about the middle of October, Birds which we call cahouze and Pimlicoes come in. The Cahouze continue til the beginning of June in great abundance, they are bigger bodied than a Pigeon & of a very firm & good flesh. They are taken with ease if one do but sit downe in a darke night and make a noise, there will more come to him then he shall be able to kill: some have told me that they have taken twelve or fourteen dozen in an hower. When the Cahouze time is out, other birds called noddies and sandie birds come in, and continue till the latter end of August." This is the only account that gives definitely the time of its arrival and departure (old style).

The following extract is from the early part of Governor Butler's "Historye," written about 1619, as shown by internal evidence:

"For the cahowe (for so soundes his voice), it is a night bird, and all the daye long lies hidd in holes of the rocks, whence both themselves and their young are in great numbers extracted with ease, and prove (especially the young) so pleaseinge in a dish, as ashamed I am to tell how many dosen of them have been devoured by some one of our northern stomacks, even at one only meale."

* These peculiarities do not apply to the shearwaters, for they are often seen swimming and feeding in small flocks, in the day time, far away from their nests. Nor are they known to utter any loud cry similar in sound to "cahow"; in fact they are rather silent birds, not even making an outcry when pulled off their eggs; nor are they to be seen hovering over the water. See under "Pimligo," below.

This is the only original statement that I find, among the early writings, that it lived in holes of rocks. It is possible, however, that it lived in all available holes, either in those made in the soil by the abundant land crabs or those found among rocks. It may not have made its own burrows, when other holes were available. Captain John Smith's account was compiled from those given above. He did not visit Bermuda.

The following account, also from Governor Butler's "Historye," relates to the famine of 1615 (see ch. 23, p. 552), and shows one principal cause of the very rapid extermination of the birds:

"Whilst this Pinnace was on her way for England, scarcetie and famine every day more and more prevayleinge upon the sickly colony, caused the governour to look well about him; in the beginning of the newe yeare, therefore [1615], 150 persons of the most ancient, sick, and weake, wer sent into Coopers Iland, ther to be relieved by the comeinge in of the sea-birds, especially the Cahowes, wher, by this half hunger-starved company, they are found in infinite numbers, and with all so tame and amazed they are, that upon the least howeteinge or noyce, they would fall downe, and light upon their shoulders as they went, and leggs as they satt, suffering themselves to be caught faster than they could be killed" "Wittnesse the generall carriage and behaviour of this company, who being thus arrived and gott up to a libertie and choice of eateing as much as they would, how monstrous was it to see, how greedily everything was swallowed downe; how incredible to speake, how many dozen of thoes poore silly creatures, that even offered themselves to the slaughter, wer tumbled downe into their bottomlesse mawes: wherupon (as the sore effect of so ranck a cause, the birds with all being exceedeingly fatt) then sodenly followed a generall surfettinge, much sicknesse, and many of their deathes."

The season of the year when these people were sent to Cooper's Island confirms the statement that the cahow was the bird that they fed upon and destroyed so ruthlessly.

In the "Plain and True Relation" by the Rev. Lewis Hughes, London, 1621, there is also a graphic account of the famine of 1615, from which the following extract is taken:

"The first night that I lay in the Iland, which you call Coopers Iland (whither the lazie starving crewe were sent, and with them some honest industrious persons, though then much out of heart, and now living and well, thanks unto God) when I saw in every Cabbin Pots and kettles full of birds boyling, and some on spits rosting,

and the silly wilde birds comming so tame into my cabbin and goe so familiarly betweene my feet, and round about the cabbin, and into the fire, with a strange lamentable noyse, as though they did bemoan us, and bid us to take, kill, roast, and eate them : I was much amazed, and at length said within myselfe, surely the tameness of these wilde birds, and their offring of themselves to be taken, is a manifest token of the goodnesse of God even of his love, his care, his mercy and power working together, to save this people from starving. Mr. Moore, then Governour, fearing that their overeating themselves would be their destruction, did remove them from thence to Port Royoll, where they found but little or no want; for birds they had there also, brought to them every weeke, from the Ilands adjoyning, whither some were sent of purpose to bird for them."

That Mr. Hughes referred mainly to the cahow, though he did not mention the name of the "silly birds," may be properly inferred, because of the season, "beginning of the newe yeare," when the large party of starving settlers was sent there for food, for the egg-birds did not arrive until the first of May. This famine with the sending of a large number of starving persons to feed on the defenceless birds at their breeding season, was unquestionably the direct and principal cause of their very rapid extermination, for it was during the next year (1616) that the first law was passed, "but overlate," restricting the "spoyle and havock of the cahowes."

Capt. John Smith's account of this event is as follows :

"Thus famine and misery caused Governour More leave all his workes, and send them abroad to get what they could ; one hundred and fifty of the most weake and sicke he sent to Coupers Isle, where were such infinite numbers of the Birds called Cahowes, which were so fearlesse they might take so many as they would."

These accounts of the habits of the cahow would not, in the least, apply to the shearwater. It is probable that another nocturnal bird called "Pimlico" by the early settlers was the shearwater; the latter is still called "pimlico" by the native fishermen. (See below.)

Although it was very unfortunate that Governor Moore was obliged to place those famished people on Cooper's Island during the breeding season of the birds, it is evident that he had no other resource. No other food could be had, at that season, to keep the people from sheer starvation. How long they remained there is uncertain, but it was long enough to exterminate nearly all the breeding birds. They may, perhaps, have remained till the egg-birds arrived in spring, and thus helped to exterminate these birds also.

Indeed, part of Hughes' account might apply better to the terns than to the cahow, but he does not give the date of his visit to Cooper's Island. To have remained for the egg-birds would imply a sojourn of about four or five months on Cooper's Island.

There are several references to this bird in the local laws of Bermuda. Even so early as 1616, a law was passed restricting the taking of the bird and its eggs, because of the rapid decrease in its numbers. It is thus referred to in Governor Butler's "Historye":

"In the same moneth he held his second generall Assize at St. George's, as irregularly as the first, wherin not any matter of note was handled, only a proclamation (or rather article, as it was then tearmed) was published (but overlate) against the spoyle and havock of the cahowes, and other birds, which already wer almost all of them killed and scared awaye very improvidently by fire, diggeinge, stoneinge, and all kinds of murtheringes."

Among the laws enacted by the Bermuda Company, 1621–22, was the following:

"The Governour, and other officers, shall take care for the preservation of the breed of Birds, by reserving to them those Ilands whereunto they resort."

This doubtless refers to the egg-birds as well as to the cahow, but it was "overlate," like the former law, for before that time the cahows and the egg-birds had been practically exterminated.*

The cahow is said to have bred on various small islands to which the wild hogs could not swim. Previous to the introduction of the hogs they and the egg-birds may have bred also on the larger islands, for they had originally no natural enemies there. The hogs would certainly have exterminated them from all the islands to which they could get access. But Cooper's Island is the only island mentioned by name as a breeding place. As they burrowed holes in the soil for their nests, they could have bred numerously only on those islands that had some sandy soil (shell-sand).

Cooper's Island, which contains about 77 acres, has a large amount of sandy soil, and was, therefore, admirably adapted for their use and would have afforded room for a vast number of nests. They probably bred, also, on Nonesuch, St. David's, Charles Island, etc., in those parts that are sandy.

* Capt. John Smith in his General History of Virginia, etc. (ed. of 1629), states that the cahows and egg-birds were "all gone" at that date.

It has long been thought, but without any evidence, that "Gurnet Head Rock" (pl. lxxix, fig. 1) was one of its breeding places, and from its isolation and inaccessibility, the only place where it might have continued to live long after it had disappeared elsewhere.

Perhaps this was partly due to a misunderstanding of the name, which, as I have elsewhere shown, does not refer to a bird but to a fish. (See pp. 454–6 for the history of this name.)

Mr. J. L. Hurdis in 1849, visited this rock, which is a small precipitous island, situated off Castle Harbor, and found there the nests of a shearwater (doubtless Audubon's shearwater) *in the crevices of the rocks.* He therefore concluded that he had found and identified the long lost cahow. His identification has been accepted by other later writers on the ornithology of the Bermudas, apparently without any adequate consideration of the facts stated by the early writers from personal observation. Among others, Newton, in his Dictionary of Birds, 1890–93, has adopted the same view, but without any additional evidence and without critical discussion of the records.

Mr. John T. Bartram, a resident of Bermuda, after long experience in collecting the birds and their eggs, concluded (1878) that the original Cahow was extinct, and that the Pimlico was the dusky shear-water (*Puffinus Auduboni*). Capt. S. G. Reid (1884) was inclined to adopt Bartram's opinion, but suggested that the Cahow might have been one of the larger Shearwaters, still found there occasionally, but in his formal list he put it under *P. obscurus*,= *Auduboni*. Bartram was doubtless correct in this case.

Governor Butler and the Rev. Lewis Hughes stated that a boat could go to its breeding places and get a load of the bird and its eggs in a short time (see also Strachy's account, above). This was apparently done only in the night. Therefore the islands visited must have been near at hand and easily accessible, with safe landings, even in winter, when the eggs were sought. Gurnet Head Rock does not fulfill any of these conditions. It is several miles from St. George's, then the chief settlement and capital; it stands isolated outside all the other islands, so that it is exposed to the full force of the sea on all sides, and in December and January the sea is here always boisterous; it has no place where a boat can safely land, unless in nearly calm weather and by daylight; its sides are formed by nearly perpendicular, exceedingly rough, high cliffs, which can hardly be scaled without risk of loss of life or limbs, unless by means of ropes and ladders. Moreover, the top is of very small area and almost

destitute of soil. So that there is no possible chance for a bird like the cahow to burrow there. The writer, with two companions, visited this island about the first of May, 1901, on a day when the sea was not very rough and the tide was low. We found it impossible to land except by stepping out upon a narrow, slippery, and treacherous reef of rotten rock and corallines, covered with seaweeds, exposed only at low tide, and standing a little way from the shore, with deep water between. The sea was breaking over this reef, and it was difficult to wade ashore except at one place, on account of the depth of water. With the aid of a long pole the writer climbed partly up the side of the rock, at the only available place, on the inner side at least,* and though he did not reach the summit, ascertained that there is no soil on the top, but only a few seaside shrubs and herbaceous plants, growing from crevices of the rock. This was sufficient to prove that the cahow never bred on this rock, and if it had, the early settlers would never have gone there in the winter and at night to get the eggs or birds.

It is far more probable that one of its smaller breeding places was on Charles or Goat Island, which is a larger, barren, uninhabited island about half a mile inside of Gurnet Head Rock. It has a beach of shell-sand on the inner side where boats can safely land. On this island, near the north side, there was a deep deposit of sand and soil, which was early used as a burial place for the soldiers who died in the old fortifications on this and the adjacent Castle Island and Southampton Island. Indeed, we found two human skeletons partly exposed in this bank of sand, where it had been recently undermined by the sea. Evidently a large amount of this sandy deposit, which contains numerous fossil land snails of a species not now living on the smaller islands (*Pœcilozonites Bermudensis*), has been washed away since the time when the old "Charles Fort" was built here, about 1615. This sandy patch would have been a suitable place for the nests of the cahow.

It may have bred to some small extent on Castle Island, but the amount of sandy soil was small there. These and other adjacent islands, including Cooper's Island, were fortified between 1612 and 1621, and it is probable that their occupation, at that time, was one of the causes of the rapid extermination of the cahow and egg-birds.

We endeavored to secure some bones of the cahow by digging in

* It is quite possible that there may be a better place to ascend the rock on the seaward side, where we could not land on account of the surf, but the boatmen denied this.

the rubbish heaps about the old forts on Castle Island, but though we found numerous bones of fishes, hogs, etc., and a few of birds, none of them belong to the cahow. But probably the deposits that we excavated were of too late a date, for the Castle Island forts were again garrisoned during the war of 1812. (See pp. 462, 463.)

We were, much to our regret, unable, for lack of time, to dig for the bones of the cahow on Cooper's Island. Much of the land there is now cultivated. The loose ground is full of the holes of two species of land crabs. One of these is a very large species (*Cardisoma Guanhumi*), whose holes may easily have served the cahow for nesting places in early times.

The chances of finding bones of the cahow would probably be much better on Cooper's Island than elsewhere, judging by the above quoted narratives of Governor Butler and Mr. Hughes.

The soil of calcareous sand on these islands is admirably adapted for the long preservation of bones and shells. Therefore it is reasonable to expect that some fortunate party may yet discover the skeleton of a cahow, by which its real nature may be determined.

That its identification with the shearwater or "pimlico" by Mr. Hurdis was an unfortunate error, seems absolutely certain. The latter differs in size, color, structure, manner and time of nesting, and other habits, flavor of flesh and eggs.

It even seems improbable that the cahow belonged to the petrel family. It appears to me more probable that it was allied to the auks (Alcidæ), many of which burrow in the ground and lay white, edible eggs. The northern auks have edible flesh and often a strong hooked bill. But no existing species breeds so far south, nor do they breed in winter. The cahow may have spent the summer in the southern hemisphere; or it may have been a localized pelagic species, coming to the land only for breeding purposes.

Known Characteristics of the Cahow.

The peculiarities of this bird, so far as known, can be briefly summarized as follows:

1. The cahow is an extinct web-footed sea-bird, unknown to ornithologists. It rapidly became extinct about 285 years ago, as the direct result of the occupation by the earliest settlers of the islands on which it bred.

2. It was not a shearwater, nor like any other member of the petrel family. It may have been related to the auks (Alcidæ), some

of which have similar white eggs and burrowing habits, and are edible.

3. It was strictly nocturnal in its habits. It flew only at night and made a "strange hollow and harsh howling" and a loud call, from which its name (cahow) was given. It came readily to persons imitating its note, and could then be easily taken by the hand, in the night.

4. It had good powers of flight, but could also run about on the ground without difficulty. It was very tame and unsuspicious.

5. It nested generally, if not always, in burrows in the soil, and laid a single, large, white egg, of good flavor, like a hen's egg in size and taste.

6. It arrived at the Bermudas in October or November (old style) and remained till about the first of June (*Hughes*).

7. It laid its eggs in December and January, "in the coldest months of the year." In this respect it differed from all other sea-birds of the northern hemisphere. Therefore it probably spent its summer south of the equator, or else it was a local pelagic species that remained constantly at sea in summer, perhaps not far away.

8. In size it was compared to a "pigeon," to a "green plover," and to a "partridge." Therefore its egg must have been very large in comparison with the size of the body of the bird. The large number of birds said to have been eaten at a meal also indicates a rather small bird.

9. It had a strong hooked bill and could bite viciously. No mention was made of its ejecting oily or other matter from its bill for defence, as do the petrels.

10. Its color was "russet-brown" on the back; its quill-feathers were russet-brown and white; its belly was white (*Strachy*).

In this combination of characters it differed from all known birds.*

d.—The Pimlico or *Audubon's Shearwater.* (*Puffinus Auduboni* Finsch, 1872 = *P. obscurus* of Hurdis and Reid.)

The early writers refer to a nocturnal bird that they called the "Pimlico" (spelled pimplicoe by Butler, and pemblyco by Capt. Smith) from its peculiar note, helped out, as Governor Butler sug-

* These views have also been maintained by the writer in an article on the Cahow in Popular Science Monthly, vol. lx, p. 22, Nov., 1901, and in Annals and Mag. Nat. History, vol. ix, p. 26, Jan., 1902.

gested, by considerable imagination and some fond recollections of a favorite locality in England.*

However, it is peculiar that the same name is not only used for the same bird, to this day, by the fishermen in Bermuda, but it is also still used for the same bird by the natives in the Bahamas, where it breeds.†

Governor Butler's account, 1619, is as follows: "Another smale birde ther is, the which, by some ale-hanters of London sent over hether, hath bin termed the pimplicoe, for so they imagine (and a little resemblance putts them in mind of a place so dearely beloved), her note articulates; and this also, for the most part, is a bird of the night, and whensoever she sings is too true a prophett of black and foule weather.‡

The superstition that this bird is a sign of bad weather still prevails among the fishermen and sailors.

This bird was found by Mr. Bartram breeding as late as about 1874, in the holes and crevices of the rocks on several of the small, barren islands about Castle Harbor.§ Capt. Reid says that he found two nests with young birds in 1874, and kept one alive for some time. It always lays its eggs in crevices of the rocks, without any definite nest.

Mr. Wedderburn, Capt. Drummond, and Mr. Ord visited Gurnet Head Rock, May 20th, 1850, and found two nests with a young one in each, and also secured one egg at that date, but did not see the

* According to Governor Lefroy, the original Pimlico was a well-known ale house and place of resort near Hogsden. It was referred to in "The Alchemist," act V, sc 1., 1610, and in other works of that period, e. g.:

"Sir Lionel. 'I have sent my daughter this morning as far
As *Pimlico*, to fetch a draught of Derby ale, that it
May fetch a colour in her cheeks.' Tu Quoque, 1614."

The name was subsequently adopted for a similar place near Chelsea, and so eventually extended to the whole of that district

† In Australia this name is given by the natives to the Friar Bird, on account of its peculiar notes, although there is no other resemblance between that bird and the shearwater

‡ The accounts of this and the other birds given by Capt. John Smith were evidently borrowed, with small verbal changes that did not improve them, directly from Butler's Historye, but he seems to credit them to Norwood. He added some observations taken from Strachy and Hughes, and made some mistakes in his compilations, as when he said the eggs of the Cahow were "speckled, the others [egg-birds] white," just reversing the facts.

§ Mr. Bartram also found a nest of a larger shearwater (*P. Anglorum?*), April, 1864, and May 1, 1877, on one of these islets.

old birds. This date is quite contrary to the time of breeding of the cahow, but agrees well with the time of breeding of this shearwater in the Bahamas. Whether the pimlico still breeds here in small numbers, on the small uninhabited islands, is uncertain. We did not see it in 1898, nor in 1901.

Dr. Henry Bryant* gave a good account of the breeding habits of this bird on the Bahamas, in 1859. The following is his description of a freshly taken adult bird :

"All the upper parts, wings, and tail, sooty brown ; below, white ; the boundaries of the colors not abruptly marked ; bill bluish, with the tips of the mandibles black ; this latter color running up the culmen to the forehead. Tarsi and feet pale flesh-color, with the posterior edge of the tarsus, the whole sole, and the upper and outer surface of the outer toe, running obliquely backward at the tarsal extremity to the hind part of the tarsus, black."

	♂	♀
Length	.344	.340
Length to end of claws	.350	.345
Length to end of wings	.497	.480
Extent	.690	.666
Wing from flexure	.217	.205
Tarsus	.037	036
Middle toe	.041	.038
Bill along ridge	.035	.036
Gape	.0445	.044

He found them nesting there March 24th ; both sexes incubating in turn. He states that the eggs do not much resemble a hen's egg, for they are highly polished and much more fragile, and vary a good deal, both in size and form. The old birds are never seen to enter their holes in the daytime, but may be seen feeding in flocks at sea.

e.—The Tropic Bird.

Tropic Bird ; Long-tail ; Boatswain Bird. (*Phaëton flavirostris* Br) See p. 428.

PLATE LXXII ; FIGURE 1.

This graceful bird was mentioned by some of the early writers, particularly by Governor Butler, in 1619, whose account was copied nearly verbatim by Capt. John Smith, and published by him in 1624. Gov. Butler's account is as follows :

"Some few other kindes of foule ther are also, which are unknowen in our partes ; as the tropick birde, which is as large as a pullett, in coulour white, with one only very long feather in the tayle, and hath

* Proc. Boston Soc. Nat. History, vii, p. 132.

its name (as I think) by reason it is never seene, either to the northward or southward, far distant from one of the two tropicks."

That it was called "Boatswain Bird" by the early settlers is evident, for it gave that name* to a small island near Spanish Point where it nested. This name appears on various maps, including the Admiralty chart of 1874.

As the flesh and eggs of the Tropic Bird are scarcely edible, it never was destroyed to any great extent for food. At one time, some twenty years ago, it was in some danger of extermination for millinery purposes. But it has been pretty well protected by the laws in recent years.† Still it is probably far less abundant than in the early times of the colony.

Mr. A. H. Verrill found, in 1901, large numbers of the very injurious "Spiral Snail" (*Rumina decollata*) in the stomachs of some specimens, in April, together with broken sea-urchins and the remains of fishes. If it has acquired a decided taste for this snail, as indicated by these instances, it will prove a great blessing to the farmers, for the snail is very prolific and has few natural enemies, so that it has already rapidly spread over all the Main Island. On some occasions it was seen in the act of eating the snails.

Contrary to the statements of several writers, we often saw these birds swimming on the surface of the water. We estimated that there may have been 2,000 pairs breeding about the islands in 1901.

f.—The Herons and Egrets.

The early writers speak of herons as abundant and breeding—especially the White Herons. Probably both the White Egret (*Ardea egretta*) and the Snowy Heron (*Ardea candidissima*) were breeding there at first, as well as the Great Blue Heron (*Ardea herodias*), which has been found breeding occasionally in modern times. The white herons still occur, but probably rarely breed.

Strachy's account is as follows: "There are also great store and plenty of Herons and those are so familiar and tame, that we beate them downe from the trees with stones and staves; but, such were

* On some modern maps the name of this island has been corrupted to "Boasting Bird Island."

† A law passed in 1881 imposes a fine of £5 and costs for killing any one of the various singing birds (enumerated), resident game birds, long-tail, crane or heron, woodpecker, kingfisher, etc.; and a fine of 5sh and cost for every egg taken or destroyed. The same law offers a premium of 4sh for every crow destroyed, and 1sh for every crow egg destroyed.

young Herons: besides many white Herons, without so much as a blacke or grey feather on them: with other birds so tame and gentle that a man walking in the woods with a sticke and whistling to them, they will come and gaze on you so neare that you may strike and kill many of them with your sticke."

Hearn Bay or "White Hearn Bay," as it was called on Norwood's map of 1626, was one of the principal breeding places, but probably there were others in the mangrove swamps.

The wanton destruction of the White Herons or Egrets and their nests, in early times, very soon attracted the attention of the Governor and Council, for the following law was made in 1621, according to Governor Butler:

"A proclamation came then abroad also for the preservation of wilde foule, and in particular for the white hearnes, for their breedinge time draweinge nere, it was doubted that, by the encrease of newe commers, and especially boyes, a great waste might be practised upon them by the takeing away of their eggs and spoyleing of their nests."

In spite of this law which, like many others, was probably never enforced, the White Herons were soon nearly or quite exterminated or driven away. There is no evidence that they bred regularly or ordinarily on the islands for over 230 years, from 1650 to 1880. Hurdis, during his residence of 14 years, recorded both species of white herons, but only as rather rare migrants.

Since they and their nests have been protected by the bird law of 1881, and still more, perhaps, by public sentiment, one or two pairs have occasionally returned to breed. Perhaps, with strict protection, more may eventually come back. Apparently one pair of egrets had bred in 1890.

g.—The American Crow. (*Corvus Americanus* Aud.)

The crows were abundant and very tame when the islands were first settled, according to Governor Butler and other early writers; but by constant persecution they were soon mostly driven away or killed. Probably a few pairs have always remained as residents of the islands, nesting in the remoter parts in thick cedars. Possibly the Fish Crow may also have been native here at first. For Governor Butler's statement, see p. 665.

Mr. Hurdis, about 1849–54, found it breeding in small numbers, and estimated that there were about 12 to 15 pairs living on the

islands at that time. Capt. Reid noticed a few pairs breeding, and found one or two nests in April, 1875. He mentions seeing as many as 16 in a flock. It has been stated, but without good evidence, that it was introduced from Nova Scotia about 1846, but it certainly existed here long before. Whether the species had been entirely exterminated here before that date is not known. It is more likely that the few individuals left were so wary and shy that they were seldom seen.

In 1881 the legislature offered a bounty for their destruction (see p. 680), which seems to us a very mistaken policy, for they destroy large numbers of noxious insects and insect larvæ, thus doing much more good than harm.

In 1901 we saw very few crows, and the species is evidently rapidly disappearing from the islands.

30.—*Partial Extermination of the Whales.*

a.—The Hump-back Whale (*Megaptera boöps* (L.) or *M. nodosa* Bonnat)

FIGURE 44.

According to the early writers whales were at first very abundant and tame about the Bermudas. The common species was the Hump-back Whale, which arrived here about the last of February or first of March, during its northward migrations, and remained till about the 1st of June. Most of these were females, accompanied by a suckling "cub," 15 to 30 feet long.

Figure 44.—Hump-back Whale (*Megaptera boöps* L. or *M. nodosa* Bonnat.). After G. O. Sars.

But the Biscay Right Whale was also sometimes seen here, and occasionally a "Fin-back," but the latter was seldom if ever taken, on account of its pugnacity. The Sperm Whale was also common, though never abundant. In the 17th century it was rarely taken, but in the 18th century many were killed. At the present time all

these whales have become rare. The Hump-back and the Biscay Right Whale are practically extinct in these waters. The Sperm Whale is still taken occasionally, but must be considered uncommon.

The following is the statement of Silvanus Jourdan, 1610:

"There hath beene likewise found some good quantitie of Ambergreece, and that of the best sort. There are also great plentie whales which I conceive are very easie to bee killed, for they come so usually and ordinarilie to the shore, that wee heard them oftentimes in the night abed; and have seene many of them neare the shoare, in the day time."

The following is an extract from the letter of Richard Stafford (see p. 510) to the Royal Society of London, in 1668, (Trans., iii, p 792). The first part evidently refers to the common Hump-back Whale:

"We have hereabout very many sorts of Fishes. There is amongst them great store of Whales, which in March, April and May use our Coast. I have my self killed many of them. Their Females have abundance of Milk, which their young ones suck out of the Teats, that grow by their Navell. They have no Teeth, but feed on Mosse,* growing on the Rocks at the bottom, during these three Moneths, and at no other season of the year. When that is consumed and gone, the Whales go away also. These we kill for their Oyl. But here have been Sperma-Ceti-Whales [Sperm Whales] driven upon the shore, which Sperma (as they call it) lies all over the Body of those Whales. These have divers Teeth, which may be about as big as a Mans wrist; and I hope by the next opportunity to send you one of them. My self with about 20 more have agreed to try whether we can master and kill them, for I could never hear of any of that sort that were killed by any man; such is their fierceness and swiftness. One such Whale would be worth many hundred pounds. They are very strong, and inlayed with sinews all over their Body, which may be drawn out thirty fathom long."

The identity of the commonest Bermuda whale has always remained in doubt. No specimens of the skull or skeleton have ever

* This was a common notion at that period, apparently due to the appearance of the contents of the stomach, simulating moss or sea-weeds. Probably the tentacles of jelly-fishes and the remains of various other small surface animals gave this appearance, but more or less of the abundant floating sea-weeds (*Sargassum*, etc.) would naturally be swallowed with the animal food which they captured at the surface of the sea, for they take in everything within range of the open mouth, as they swim along.

Mr. Hayward of St. David's Island states that they fed on jelly fishes.

been studied by any zoölogist, so far as I can learn. Nor are there any complete descriptions of its external characters. There were doubtless two or three distinct species of whalebone whales taken or seen in former times. Of these the one called the Cape Whale by the fishermen was, without doubt, the Biscay Right Whale. It certainly was not the Greenland Right Whale, as Matthew Jones supposed. The Biscay Whale was formerly common off the eastern coast of the United States, and is still occasionally seen there. Therefore it naturally would sometimes have visited the waters of Bermuda.

The best local description of the common Bermuda Whale that I have seen was written by an anonymous writer to the Royal Society of London, and published in vol. i, p. 11, of their Transactions, in 1665. This writer stated that several unsuccessful attempts had been made to take them that year, but without much success. Yet two adult females and three "cubs," 25 to 30 feet long, were killed. One female was 60 feet long. The other was 88 feet long;* tail 23 feet; swimming fin [flipper] 26 feet; "gills" [baleen] 3 feet long. It had a dorsal fin on the hinder part of the back. The color was black above; white beneath. The head was somewhat bluff.

The presence of a dorsal fin, the blunt head, and the very long flippers show that this must have been the true Hump-back Whale† (*Megaptera nodosa* Bonnat.) of Europe and America.

In a later letter, the same writer states (op. cit., ii, p. 132) that in 1666 sixteen whales had been taken, yielding 50 to 60 tuns of oil. He does not mention any difference. The small amount and shortness of the baleen was quite unlike that of the Biscay Whale.

We can only judge of its abundance by the records of the amount of oil shipped, after the whale fishery was organized in 1665. Some data in regard to this early fishery have been given on a previous page (p. 521). Therefore it will be sufficient to add, in this place, the following records, which evidently refer mainly or entirely to the Hump-back, and supplement those given previously.

* This is an unusually large size for a specimen of this whale, but the other measurements are in good proportions to the length. In more modern times, specimens of 50 feet in length were considered large. Mayor Hayward says he never knew of one over 60 feet. Mr. Hayward of St. David's says 50 feet was the largest size, and that the average yield was 30 to 38 barrels of oil, very rarely 70 barrels. This whale of 1665 must have been a giant specimen of its race.

† It has, however, received a special name (*M. Americana* Gray), based entirely on the above description. It is also identical with *M. longimana*, and with *M. bellicosa* Cope, of the West Indies, according to the determinations made by Dr. F. W. True. (See Science for May 2, 1902, p. 690.)

Governor Heydon and Council reported to the Bermuda Company, June 22, 1669, that according to the husband's account, in 1664, 44 hogsheads of "whale oyl with blubber" and "400 weight of ffins" [bone] were sent to London in the "Elias"; in 1666, 117 hhds. of oil; in 1667, 47½ tuns of oil. In all, 131 tuns of oil had been sent in four years.

Governor Coney, in 1685, reported to the Royal Committee that about fourteen whales had been killed that year, but no account of the oil had been made to him, for the people claimed it as their own property He stated that a large whale was then worth £80.

After the Bermudas became a crown colony, in 1685, the whale fishery was carried on with greater activity than before, especially as the cultivation of tobacco had become unprofitable and was rapidly abandoned, about 1700. But during most of the 18th century a special license to carry on this fishery was required, for which a considerable fee was charged by the governor. The fishery did not become free till the time of Governor Brown, 1782, or about the close of the Revolutionary War. Perhaps this measure was due partly to the poverty of the people and the lack of other commercial resources, at that time, for the war caused, very hard times in Bermuda, as did the subsequent war with France.

However, the continuous killing of the whales, during the 18th century and later, gradually reduced their numbers, so that for the past fifty years they have been rarely captured. In fact, for forty or fifty years, the Sperm Whale has apparently been much more frequently taken than the Hump-back.

As the Hump-back is a migratory whale, visiting the West Indies in winter and the New England coast in summer, the fishery at Bermuda was not the only cause of its decrease in numbers. Probably the New England whale fishermen killed as many, and perhaps many more, than the Bermudians.* This was certainly the case with the Biscay Whales, which were formerly taken in large numbers off the New England coast, but apparently only in small numbers at Bermuda.

* From 1765 to 1770, there were from 100 to 125 American vessels engaged in whaling, taking from 11,000 to 19,000 bbls. of oil annually. From 1771 to 1775 the average annual number was 304 vessels, tonnage 27,840, sperm oil taken 89,890 bbls.; other whale oil 8,650 bbls. In 1839, 557 American vessels, mostly from New England, were engaged in this fishery; in 1843 the number was 652; in 1846, 678 ships, 35 brigs, and 22 schooners, with a total tonnage of 233,189 tons.

From what is known of the migratory habits of the Hump-backs, on the American coasts, they probably go south in the autumn, as far at least as the West Indies, or even South America, to spend the winter, and while there bring forth their young. In the last of the winter or early spring they start northward, probably following, for the most part, the course of the Gulf Stream. But groups of them, mostly females with their young, were in the habit of tarrying, during the spring months, about the Bermudas, leaving for the northern waters about the last of May or first half of June, and sometimes not till July. Perhaps the same individuals did not remain there all that time, but those that left early may have been replaced by later arrivals from the south.

Whether any of the young ones were ordinarily born in Bermuda waters is uncertain.* From the small size of some of the "cubs" taken with their mothers (15 feet long) it is not improbable that some were born there ; but most of the cubs were 20 to 30 feet long, and those must have been born in more southern seas. We do not have many facts as to the rate of growth of these young whales, but probably it takes several months for them to become 25 feet long.

It appears, from the early accounts, that the females with their cubs used to come into shallow water, near the shores and reefs ; sometimes, though rarely, they penetrated through the reefs by the channels and entered the lagoon, as far as Murray anchorage, at least.

An instance of this kind is recorded in 1803, by an officer of H. M. S. "Leander," who stated that a whale, probably of this species, in Murray anchorage, while he was near it in a cutter, leaped like a salmon, with a sudden spring, entirely out of the sea, so that its body was horizontal in the air and half its breadth above the water. It caused a great commotion when it fell heavily back into the sea, "with a thundering crash."

Early writers speak of its playing with its young, often tossing them quite out of the water with its snout, when so near the south shore that they could be easily observed. This was done particularly in pleasant moonlight nights. But no such sight has been seen during the past sixty years, so far as I can learn.

Bermuda newspapers have records of the capture of single specimens, mostly young, showing quite conclusively that they have been comparatively rare for sixty years or more.

* The whale fishermen at Bermuda do not think that the whales were in the habit of breeding there

One instance, April, 1866, is given, when a small Hump-back, "a maiden cub of last year," 33 feet long, was taken, yielding 40 barrels of oil. At the same time it was stated that it was the first one that had been taken "for some years." Another is mentioned April 26, 1871, a "cub" 22 feet long, yielding 5½ barrels of oil. It was accompanied by its mother, which followed the cub and "struck the boat with its tail," but she was not captured. The flesh of these young whales is eaten by many of the natives of Bermuda, and is considered very good meat, though it always has a flavor of whale oil, more or less evident.

The Royal Gazette, Dec. 23d, 1879, records a large school of whales observed off Bermuda. "The barque Elsinore, which arrived at New York on the 23d of October, from Rio Janeiro, reports that six days before, when abreast of Bermuda, she passed through an immense shoal of whales. . . . The procession must have been at least two miles long" These were probably Hump-backs migrating southward. Apparently they do not visit Bermuda during their autumnal migrations.

Since this date large numbers of Hump-backs, Fin-backs, and other whales have been killed in Massachusetts Bay and northward, by means of bomb-lances, so that their numbers on the New England coast are now greatly diminished.*

* In 1859, I personally observed large schools of Hump-backs, with some Fin-backs, in the Bay of Fundy. They were especially numerous at the seining grounds known as the "Ripplings," east of Grand Menan Island, towards the center of the Bay, where the strong opposed tidal currents make a large area of very rough water during flood tide, in which a vast school of large herrings were feeding upon an abundant surface shrimp (*Thysanopoda norvegica*). The whales were feeding both on the herring and shrimp, and were so tame and so intent on their feeding that they often came within an oar-length of the numerous boats and vessels engaged in seining the herring, often, indeed, passing under the bowsprits of the vessels. At that time they were never disturbed by the fishermen, and they rarely came in contact with the nets and boats, which they carefully avoided by turning aside or diving under them. There were dozens of them in sight at once. Many that I saw were 60 to 75 feet long, often exceeding the length of the schooners, alongside of which they often passed near enough to be touched with an oar. It was a rare and imposing sight, never to be forgotten, to see these leviathans so tame and fearless of man. One large hump-back whale, which was easily recognized by means of a large barnacle attached by the side of the blow-hole, so as to cause an abnormal noise in blowing, had frequented these waters every summer, for more than twenty years, according to the fishermen. At that time there were more than 50 vessels fishing at this place, each with 4 to 6 boats and seines in use.

b.—The Fin-back Whale. (*Balænoptera*, sp.)

It is asserted by those formerly conversant with the whale fishery, that a true Fin-back was sometimes seen, but that it was dangerously pugnacious, and therefore was not attacked. Which species this may have been is quite uncertain, but it may well have been *B. physalus* L. (See fig 44*a*.)

c.—The Cape Whale; Black Whale; Biscay Right Whale. (*Balæna glacialis* Bonnaterre = *B. cisarctica*.)

FIGURE 45

This whale, which rather closely resembles the true Right Whale or Bow-head of the Arctic Ocean, and has often been mistaken for it, is found on both sides of the Atlantic, in temperate latitudes, entirely south of the range of the Bow-head, which is strictly confined to the arctic seas.

It has, apparently, never been common at the Bermudas, occurring there at long intervals, irregularly and in small numbers, though it was doubtless more common in early times than now, but the early records are usually not explicit enough to distinguish it from the Hump-back. It is a shorter and thicker species, with a stout, bluff head, and no dorsal fin. The slabs of whalebone are much more valuable, and are often 6 to 8 feet long.

Figure 44*a*.—Fin-back (*B. physalus*).

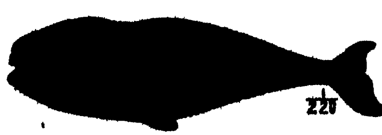

Figure 45.—The Biscay Right Whale or Cape Whale.

I have learned from Mr. Hayward of St. David's Island, who formerly engaged in the whale fishery, that these whales were occasionally taken, but were always comparatively rare. He also states that one was taken in Castle Harbor, in 1792, which is the only known instance of a whale being taken in the enclosed bays of the islands. Mayor J. M. Hayward, of St. George's, tells me that a pair of them were taken about 1840.

But I have not been able to find positive records of any more recent captures of this kind, though Mayor Hayward thinks that two or three of them may have been taken since that date.

d.—The Sperm Whale; Spermaceti Whale; Trompe Whale; Trunk Whale; Cachelot. (*Physeter macrocephalus* L.)

FIGURE 46.

The Sperm Whale has always been found in Bermuda waters, but it has never been abundant there, nor does it often come into shallow water. Its habits are more erratic and it does not migrate regularly, like the Hump-back. It is found in all tropical and sub-tropical seas, and seems to be particularly fond of the Gulf Stream, probably because it finds there an abundance of squids and other cephalopods, which are its favorite food. Probably its migrations are largely dependent on the supply of such food.

However, it was certainly much more abundant off Bermuda in the 17th and 18th centuries than it has been in this century. Its decrease cannot be attributed, in any great measure, to the Bermuda whalers, but rather to the American whalers, whose vessels have hunted it up and down the Gulf Stream for two centuries, killing large numbers every year.

Formerly it was very numerous in the Gulf Stream, between the Carolina Coasts and Bermuda There are records of schools containing several hundreds, or even a thousand, having been seen in that region. The number that strayed eastward, within sight of Bermuda, was comparatively small, but yet the early records often refer to their frequent occurrence, though they were rarely attacked by the local fishermen in the 17th century, for owing to their lack of knowledge and experience the few attempts that were made proved abortive and discouraging.

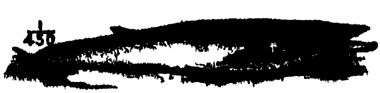

Figure 45*b*.—Fin-back or Rorqual (*B. physalus*.)

Figure 46.—Sperm Whale

But during the 18th century and more recently they have been frequently captured. In fact, it would appear that since 1800 sperm whales have been more often taken than any other kind. During the past thirty or forty years they have been almost the only whales taken. Formerly they seem to have been much larger than those

taken recently, though that may be because only the particularly large ones were then thought worthy of record.

Mayor Hayward, of St. George's, tells me that he remembers that when a child he was permitted to stand on the back of one that had been captured and brought inshore, which was 80 feet long and was said to have been the largest ever taken here. Mr. Hayward, of St. David's Island, probably refers to the same one, in the notes sent to me by his daughter, for he says that in 1839 they took a sperm whale yielding 84 barrels of oil, which was regarded as the largest one ever taken here. It was struck by Josiah Smith.

At that period Hayward's whale oil establishment at St. David's Island was one of the largest. A local paper, in 1832, in noticing the capture of a sperm whale, mentions that it was the *seventh* whale taken that season for the Hayward's. At that time about twelve boats were engaged in the pursuit of whales,—chiefly sperm whales, it appears.

Mr. Hurdis, in recording the capture of a half-grown sperm whale in 1840, remarks that it was the first one of the kind that had been captured in nine years. This is inconsistent with Mr. Hayward's statement of the capture of the large one in 1839, and of the record of seven in 1832. But at that time the communication between St. David's and Hamilton was not very easy nor rapid, so that Mr. Hurdis may have known very little about the captures of these whales. He records another, in July, 1851, as a rare capture.

Matthew Jones records the capture of one 47 feet long, in May, 1863; and of another 40 feet long, taken 14 miles south of David's Head, June 10, 1869.

Very few have been taken in recent years, the fishery having been nearly abandoned. I saw a small one, about 30 feet long, captured in April, 1901. It was regarded as a curiosity, even by the natives, and was kept several days for exhibition, under a tent, where it attracted crowds of visitors.

This whale has certainly become comparatively rare in the Atlantic Ocean, as well as in all other regions, during the past sixty years.

31.—*The Extermination of Breeding Sea Turtles; the Lizard.*

a.—Former Abundance of Sea Turtles.

Mr. Henry May and his company, 1598, and the companions of Sir George Somers, in 1609, found the sea-turtles breeding in large numbers on the sandy shores of the Bermudas, and those ship-

wrecked people, as well as the early settlers in 1612, depended very largely on their eggs and flesh for their food. At that time the turtles attained very large sizes, far beyond any found there in modern times, for being undisturbed by any enemies, they lived to a great age.

Probably most of the breeding turtles were Green Turtles, but it is likely that the Hawksbill and Loggerhead were also found here at that period.

Silvanus Jourdan gives the following account of them :

"There are also great store of Tortoises (which some call turtles), and those are so great, that I have seene a bushell of egges in one of their bellies, which are sweeter than any Henne egge : and the Tortoise itselfe is all very good meate, and yieldeth great store of oyle which is as sweete as any butter : and one of them will suffice fifty men at a meale at least : and of these hath beene taken great store, with two boates at the least forty in one day."

The following account was given by William Strachy, in 1610 :

"But even then the Tortoyses came in againe, of which wee daily both turned up great store, finding them on land, as also sculling after them in our Boate strooke them with an Iron goad, and sod, baked, and roasted them. The Tortoyse is reasonable toothsom (some say) wholsome meate. I am sure our Company liked the meate of them verie well, and one Tortoyse would goe further amongst them than three Hogs. One Turtle (for so we called them) feasted well a dozen Messes, appointing sixe to every Messe. It is such a kind of meat as a man can neither absolutely call Fish nor Flesh, keeping most what in the water, and feeding upon Sea-grasse like a Heifer, in the bottome of the Coves and Bayes, and laying their Egges (of which wee should find five hundred at a time in the opening of a shee Turtle) in the Sand by the shoare side, and so covering them close leave them to the hatching of the Sunne."

Governor Moore, in 1612, referred to the Sea-turtles as follows :

"Turkles thare bee of a mightie bignesse : one Turkle will serve or suffice three or four score at a meale, especially if it be a shee Turkle, for she will have as many Egges as will suffice fiftie or threescore at a meale ; this I can assure you, for thay are very good and wholesome meate, none of it bad, no, not so much as the very guts and maw of it, for they are exceeding fat, and make as good tripes as your beastes bellies in England."

The great number of turtles destroyed in those early years caused their rapid decrease, even before 1620. In August of that year was passed "An act agaynst the killing of over young Tortoyses."

"In regard that much waste and abuse hath been offered and yet is by sundrye lewd and imp'vident p'sons inhabitinge wthin these Islands, who in there continuall goinges out to sea for fish doe upon all occasions, and at all tymes as they can meete with them, snatch & catch up indifferentlye all kinds of Tortoyses, both yonge & old, little and greate, and soe kill, carrye awaye and devoure them to the much decay of the breed of so excellent a fishe, the daylye skarringe of them from of our shores and the danger of an utter distroyinge and losse of them. It is therefore enacted by the Authoritie of this present Assembly That from hence forward noe manner of pson or psons of what degree or condition soever he be, inhabitinge or remayning at any time within these Islands, shall p'esume to kill or cause to be killed in any Bay, Sound, Harbor or any other place out to Sea: being within five leagues round about of those Islands, any young Tortoyses that are or shall not be found to be Eighteen inches in the Breadth or Dyameter, and that upon the penaltye for everye such offence of the fforfeyture of fifteen pounds of Tobacco, whereof the one half is to be bestowed in publique uses the other upon the Informer."

b.—The Green Turtle (*Chelonia mydas* (L.) Sch. = *C. viridis* T. and S.). See p. 448.*

FIGURE 47.

At the present time this is much more common than either of the other species and is still taken in small numbers, for the market, by the turtle fishers of St. David's Island, as described in a former chapter (p. 448). Those taken in recent years are nearly all young or half-grown specimens, seldom weighing more than 70 or 80 pounds, though sometimes 150 pounds or more. They have not been known to breed on the Bermuda shores for more than two hundred years, so far as I can learn. Therefore all that are captured here come northward from the West Indies in the Gulf Stream.

In the West Indies they are believed to reach the weight of 15 to 20 pounds the first year; those weighing 80 to 100 pounds are thought to be three or four years old (Garman).

In the West Indies green turtles have been taken weighing 850 pounds and even 1000 pounds, but such giants are now very rare,

* Good accounts of the sea-turtles are given by Holbrook, North American Herpetology, ii, 1849: L. Agassiz, Contributions to the Nat. Hist. of the United States, ii, 1857; S Garman, Bull. U. S. Nat. Museum, No. 25, pp. 287-303, 1884 (with detailed synonymy); F. W. True, The Fisheries and Fishery Industries of the United States, sec. ii, p. 147, 1884.

though it seems that formerly they were not uncommonly found of similar sizes. Therefore, it is not improbable that the huge turtles mentioned as found breeding at the Bermudas by the early writers, quoted above, were really green turtles that had lived here unmolested to a great age and large size.

In proof of this, Lieut. Nelson records the finding of huge skeletons of sea turtles, nine feet long and seven feet broad, in the sand dunes. (See under Geology, Part IV.) These may well have been the bones of large green turtles, killed by the early settlers for food.

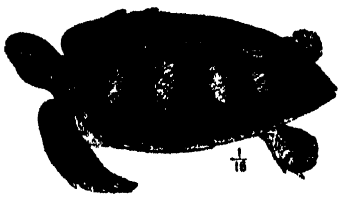

Figure 47.—Green Turtle

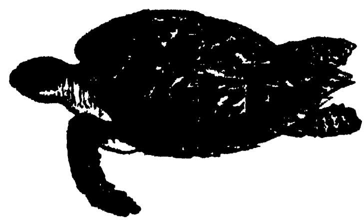

Figure 48 —Hawksbill.

In the West Indies adult turtles, not of the largest size, will lay three or four lots of eggs, or sometimes five, at intervals of 14 or 15 days, with about 75 to 200 eggs in each lot, making a new nest each time. The total number might, therefore, be 500 to 1000. Thus the number of eggs, mentioned by Strachy as contained in those large turtles, may not have been exaggerated. The eggs hatch in six to eight weeks, according to the temperature, and the young take to the water at once.*

The Green Turtle is peculiar in feeding chiefly on a vegetable diet, while the others are partly or mainly carnivorous. This species is particularly fond of the roots and crown or base of the "turtle grass" or eel-grass (*Zostera marina*), which grows in shallow water; but it will also eat various succulent sea-weeds,† and does not object to a certain amount of animal food. In confinement they will eat fish of any kind.

They have now become rather shy and wary, so that their capture, even in large seines, requires considerable skill and patience.

* The very young turtles are devoured in large numbers by various birds and fishes, and doubtless also by the hawksbill and other sea-turtles. Sharks are fond of them, even when eight to twelve inches in diameter.

† Mr. True mentions that the stomach of one taken at Noank, Conn , in 1874 was full of Irish Moss (*Chondrus crispus*), a very succulent and nutritious seaweed, abundant on the rocks of the New England coast, just below ordinary low tides. This would make an excellent food for fattening these turtles in confinement.

There is every reason to believe that the Green Turtle could be raised artificially with much profit, at the Bermudas, in suitable localities, where they could be easily confined and fed on their natural food, or on some cheap substitutes.*

The Green Turtle has a wide range, being found as far south as southern Brazil, and north to Cape Hatteras; rarely on the New England coast. Their numbers are rapidly decreasing, even in the West Indies, and if not protected they will become practically extinct in a few years.

Their nests and eggs should be thoroughly protected, wherever possible, and the taking of female turtles on the beaches, while depositing their eggs, should be utterly prohibited, and a close period during their breeding season, from March to July, should be provided.†

A similar species (*C. virgata*) occurs in the Pacific and Indian Oceans, and is found on the California coast.

c.—The Hawksbill; Caret; Tortoise-shell Turtle. (*Caretta imbricata* (L.) Merr., 1820‡ = *Eretmochelys imbricata* Fitz., Agassiz).

FIGURE 48.

This species, though less common than the Green Turtle, is still frequently taken about the Bermudas, and is sold for food, though

* Whether they would breed in confinement is doubtful, but very young ones could be secured in the West Indies in large numbers, and brought to Bermuda in vessels provided with wells. They are believed to grow rapidly, but I have seen no record as to the amount of increase of those that are frequently kept in the natural fish ponds, as at Walsingham; nor do I know whether they receive an abundance of suitable food in those places. They will eat purslane (*Portulacca oleracea*) and grow fat on it (Holbrook and others). This weed is still used to feed them in the turtle ponds at Bermuda. Probably they would also eat many other land plants, such as pumpkins and cabbages.

† At present it would probably be impossible to get the various governments, owning the islands on which the turtles breed, to coöperate, to any great extent, in any such measures. They are more likely, as in the case of the fur seals, to wait until the species are exterminated before making laws to preserve them. Much might be done, however, by private owners taking up lands along the shores where they breed and protecting their nests and young, and raising the young for the northern markets.

‡ The generic name *Caretta* Merr., 1820, has clear priority over *Eretmochelys* Fitz., 1843 (as a subgenus), adopted by Agassiz, as a genus, in 1857. As used in 1820, it included also *Thalassochelys* Fitz., 1841, but the elimination of the latter restricted the name to the type, *C. imbricata*, for which it should be used. Another allied species (*C. squamata* Ag., Kr.) is found in the Pacific and Indian Oceans, and also occurs on the California coast.

at a smaller price. It is taken in seines, in the same manner. When confined in the turtle ponds it is apt to bite the Green Turtles, being more pugnacious. It is carnivorous in its diet, feeding upon fishes, mollusks, crustacea, small sea-turtles, etc. These and all the other sea-turtles are said to be very fond of the Portuguese man-of-war (*Physalia*), which they eagerly devour, shutting their eyes to avoid the stings of its tentacles, which they continually brush away with their flippers, and when thus feeding they are so preoccupied that they can easily be approached by a boat and captured by hand.* In confinement they will eat meat and fish of all kinds, as well as turtle grass and purslane. This turtle never becomes so large as the Green Turtle, seldom exceeding 150 pounds in weight, even in the West Indies, though specimens much larger are sometimes taken. Those caught about the Bermudas are generally much smaller.† In the West Indies and on the Florida Keys they breed at the same season as the Green Turtle, and lay their eggs in the same way. The eggs are well flavored and much sought after as food by the natives, like those of the Green Turtle. The flesh of the young Hawksbill is considered palatable, and is often sold in our markets, but that of the old ones becomes tough and oily, so that it is not valued as food. In fact, it is said to be often very unwholesome in the West Indies, having purgative properties, perhaps due to the food that it eats there.

The shells or dermal plates of this and the similar Pacific species, known as tortoise-shell in commerce, is of considerable value, when taken from large adult specimens. A large turtle may yield 12 to 15 pounds of shell, of different grades. The dorsal plates are the thickest and most valuable, but all are utilized.

This species ranges from Florida and the Gulf States to Brazil, and throughout the West Indies; it is rarely seen as far north as South Carolina.

d.—The Loggerhead (*Thalassochelys caretta* (L.) True. = *T. caouana* (Bon.) Fitz.)

FIGURE 49.

The Loggerhead is now rare in Bermuda waters, occurring only sporadically. Probably it was much more common in early times, for though the early writers did not distinguish the different species,

* See Mr. Garman's account, in Bulletin U. S. Nat. Mus., No. 25, p. 294.

† Governor Lefroy stated that the largest one taken in many years weighed 150 pounds.

it is quite probable that some of the largest ones referred to by them were Loggerheads, especially as their eggs were said to have been as large as goose-eggs, which would apply to this species better than to the others, for it has the largest eggs. In the West Indies and at Florida Keys it is sometimes of very large size, specimens weighing 450 pounds having been taken not infrequently. Mr. True states that it sometimes weighs 1500 or 1600 pounds, and that one which was taken in 1871, weighing about 850 pounds, was 6 feet in length and 9 feet across the outstretched flippers; the head was 11 inches long and 8 broad. Mr. Garman could get no positive evidence of any weighing over 850 pounds.

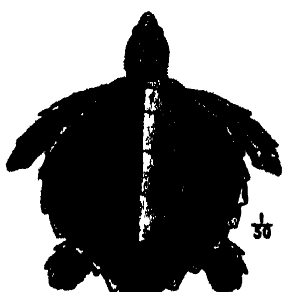
Figure 49.—Loggerhead.


Figure 50.—Leather-back.

The Loggerhead has a wide range; it is common from Virginia to Brazil, and occasionally crosses the Atlantic to the Mediterranean and the coasts of England. It breeds commonly on the coasts of Florida, Georgia and South Carolina, and rarely as far north as Virginia, while small specimens, weighing 30 to 40 pounds, are common off the North Carolina coast. Occasionally it has been taken off the New England coast, coming north in the Gulf Stream.

A similar species (*T. Japonica* (Thern.)=*olivacea* Esch.) occurs in the Pacific and Indian Oceans.

The flesh of the Loggerhead is not valued as food, though small ones are sent to the markets, but the old ones become so tough, musky, and oily, that they are undesirable. The eggs are as good as those of the other species, and are equally numerous. The shelly plates are thin and not well colored, so that they are of little value in the arts.

Its food is similar to that of the Hawksbill, but in the West Indies it has the habit of feeding also on a large massive sponge, which is therefore called the "logger-head sponge," and gives its name to

"Loggerhead Key," in the Bahamas, where it is said to grow abundantly. It is also said to be very fond of the great conch (*Strombus gigas*), and to bite off the spire of the shell in order to extract the meat.

e.—The Leather-back; Trunk Turtle; Leather Turtle. (*Sphargis coriacea* (L.) Gray.)

FIGURE 50.

This huge turtle now occurs irregularly at Bermuda, but it probably bred there in early times, with the others. Its habits are similar to those of the Loggerhead, and it has the same wide range, though it is less common.

On the American coast it has occasionally been taken as far north as New England and Nova Scotia; it migrates northwards in the Gulf Stream and sometimes crosses to Europe. The Leather-backs of the Indian and Pacific Oceans are believed to be the same species.

It grows to a larger size than either of the other species, sometimes weighing over 1600 pounds. Many specimens over 1000 pounds in weight have been recorded; such individuals are about 7 feet long.

Gosse refers to the record, in the local paper, of a specimen captured in Jamaica, April 10, 1846, while laying its eggs. Five or six dozen eggs, "the largest the size of a duck's egg," were found in the first nest, March 30th. The size was 6½ feet long; 9⅛ feet across the flippers; circumference of neck, 3¼ feet; length of hind flippers, 2⅛ feet.

f.—The Bermuda Lizard. (*Eumeces longirostris* Cope.)

FIGURE 51.

This lizard, which is a very active species, is by no means common, except in particular localities. We saw very few lizards except on Castle Island, where they are common among the ruins of the old forts and walls, and also in crevices of the cliffs. Although they may be frequently seen basking in the sun, it is difficult to obtain specimens of them, except by shooting them with dust shot, though a few were caught alive by turning over stones. They drop the tail very readily. Two styles of coloration were noticed, both in the living and preserved specimens. One of these varieties, which is distinctly striped with two latero-dorsal light lines, was thought by Mr. Garman* to be the young, but among those that we obtained

* Mr. Garman in Bull. U. S. Nat. Mus., No. 25, p. 287, note, gives a detailed description of this species.

they were as large as the unstriped ones, nor is it a sexual difference.

We also found it, in small numbers, on Charles (or Goat) Island, which has not been inhabited for 250 years, and is very dry and barren, with few insects, except ants, on which the lizard probably feeds. A few individuals were seen in certain places on the Main Island, in walls, but it was regarded as rare by the natives, many of whom had never seen it at all.

Matthew Jones, 1859, reported it as common. The early writers did not mention it, but they were not close observers of small creatures. So far as known, it is an endemic species, not very closely related to any species found elsewhere. Its occurrence on the small

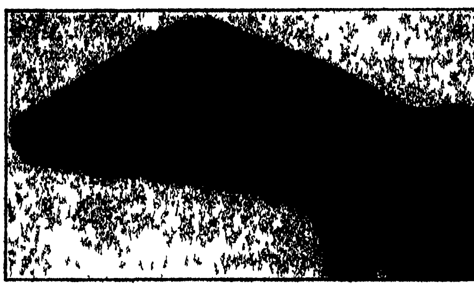

Figure 51.—Bermuda Lizard (*Eumeces longirostris*).

barren islands indicates that its occupancy dates back to a remote period when nearly all the islands were united by land.

Probably it was originally much more abundant and more generally diffused than at present. Very likely the wood-rats and common gray rats, which are abundant, prey upon its eggs and young, and thus reduce its numbers. Owing to its quickness and the inaccessible holes to which it retreats, it can scarcely be destroyed by any other enemies here. There may be no rats on Castle Island,—at least we saw no evidence of any. This may account for its greater abundance there, where food would seem to be very scarce indeed.

32.—*Decrease of certain Fishes and Shell-fish.*

a.—*Former Abundance of Fishes.*

The early writers describe, in expressive terms, the remarkable abundance of the edible fishes when they first landed, and give lists of various species that they took, most of which can easily be identi-

fied now. But they also state that the fishes soon became more shy and scarce, so that they had to go farther away at sea to catch them.

The fishes have contributed largely to the food of the Bermudians, ever since the first settlement, and therefore it is not strange that they have decreased both in number and size. But it is difficult to determine definitely how much they have decreased, for accurate records and statistics are lacking. Moreover, it is possible that natural physical causes, as in the instance given above (ch. 19), may have, in other cases, caused the death of multitudes of fishes. However, it has long been recognized in Bermuda that legal restrictions were necessary to prevent the wanton destruction of the fishes.

Silvanus Jourdan, in 1610, gave the following account of the fishes:

"Sir George Summers, a man inured to extremities (and knowing what thereunto belonged) was in this service neither idle nor backwarde, but presently by his careful industry went, and found out sufficient of many kind of fishes, and so plentifull thereof, that in half an houre he tooke so many fishes with hookes, as did suffice the whole company one day. And fish is there so abundant, that if a man steppe into the water, they will come round about him: so that men were faine to get out for feare of byting. These fishes are very fat and sweete, and of that proportion and bignesse that three of them will conveniently lade two men: those we call Rockfish.* Besides there are such store of mullets† that with a seane might be taken at one draught one thousand at the least, and infinite store of Pilchards, with divers kinds of great fishes, the names of them unknown to me: of tray fishes very great ones, and so great store, as that there hath been taken in one night with making lights, even sufficient to feed the whole company [150 persons] a day."

The following is an extract from the account of Wm. Strachy, 1610:

"The shoares and Bayes round about, when wee landed first afforded great store of fish, and that of divers kindes, and good, but

* The rock fishes (*Mycteroperca bonaci* and other species, see plate xcv, figs. 3, 4) still grow to large size, those taken off the outer reefs sometimes weighing 80 to 100 pounds, but such large specimens are not now found in shallow water. Very likely the Hamlet Grouper (plate xcv, fig. 2), may also have been here included as a Rockfish, though Hughes, in 1614, distinguished between groupers and rockfishes. This fish has always been one of the commonest of the large Bermuda market fishes, often weighing 20 to 30 pounds, but it may have been still larger and much more abundant at first.

† White Mullets (*Mugil Braziliensis*), fig. 58, are still found here, but not in great abundance. Pilchards are still abundant.

it should seeme that our fiers, which wee maintained on the shoares side drave them from us,* so as wee were in some want, untill wee had made a flat bottome Gundall of Cedar, with which wee put off farther into the Sea, and then daily hooked great store of many kindes, as excellent Angell-fish,† Salmon Peale [not identified], Bonetas, Stingray, Cabally, Scnappers, Hogge-fish (*Lachnolaimus*), Sharkes, Dogge-fish, Pilchards, Mullets, and Rock-fish, of which bee divers kindes: and of these our Governour dryed and salted, and barrelling them up, brought to sea five hundred, for he had procured Salt to bee made with some Brine, which happily was preserved, and once having made a little quantity, he kept three or foure pots boyling, and two or three men attending nothing else in an house (some little distance from his Bay) set up on purpose for the same worke.

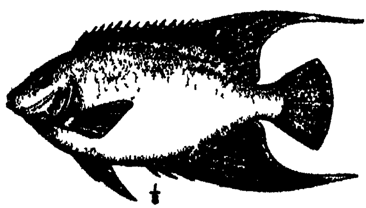

Figure 52.—Green Angel-fish.

Likewise in Furbushers building Bay wee had a large Sein, or Tramell Net, which our Governour caused to be made of the Deere Toyles, which wee were to carry to Virginia, by drawing the Masts more straight and narrow with Roape Yarne, and which reached from one side of the Dock to the other: with which (I may boldly say) wee have taken five thousand of small and great fish at one hale. As Pilchards,‡ Breames, Mullets, Rocke-fish, &c., and other kindes for which wee have no names. . . . True it is, for Fish in everie Cove and Creeke wee found Snaules, and Skulles in that abundance, as (I thinke) no Iland in the world may have greater store or better Fish."

The following is from Gov. Moore's description, 1612:

"With a hooke and line wee tooke more then our whole company was able to eate. So that there was enough to feed many more.

* This was more likely due to the constant fishing carried on at that time.

† The Green Angel-fish (*Angelichthys ciliaris*) is still common and highly esteemed as a food fish.

‡ This was probably the *Harengula macrophthalma* Ran., still called pilchard here, and often seined in large numbers in the spring.

The next day after the Sabbath wee went with our net and boat, and if we would have loaded two boats we might: and so you may do day by day. Fishes do so abound, and they be of these sorts, Mullets, Breames, Hogge fish, Rock fish and Lobsters [*Panulirus argus*], with more sorts of other Fish which I cannot name."

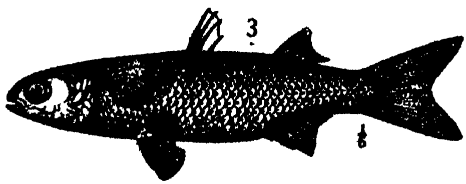

Figure 53 —White Mullet (*Mugil Braziliensis*).

The following is by the Rev. Mr. Hughes, 1614 :

"For the present Tobacco is the best commoditie, and for victuals, if men have boates, nets, lines, hookes, and striking irons, they may have good fish at all times, as Rockfish [Pl. xcv, figs. 3, 4], Angell-fish, Hogge-fish, Amberfish [*Seriola*], Cutlefish [Octopus or Squid], Pilot-fish, Hedgehogfish [*Diodon*], Cunnyfish [Coney-fish, Pl. xcv, fig. 1], Old wives, Stingraies, Snappers, Groopers, [hamlets], Cavallies, Morraies, Mullets, Mackerels, Pilchers [pilchards], Breames, Lobsters, Turtles, Sharkes, &c. Also heere are Eeles in freshwater ponds [true *Anguilla*, still found]. Rivers here are none, but ponds and welles of very good and holsome water, and a water descending from an hill, which floweth and ebbeth with the sea, and yet drinketh alwaies sweet like milke."

Governor Butler gave the following account of the fishes :

"But above all the rest of the elements the sea is found most aboundantly liberall to thes islands ; hence have they as much excel-

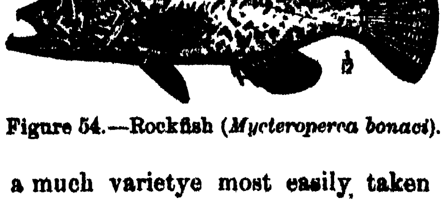

Figure 54.—Rockfish (*Mycteroperca bonaci*).

lent fish and of a much varietye most easily taken as any place in the world ; the most of which being unknown to our more northerly partes, have lately gotten them names, either from their shapes or

conditions, as the large rock fish [*Mycteroperca bonaci*, and others], from his like hewe, and hauntinge among the rockes; the fatte hogge fish [*Lachnolaimus maximus*], from his swine-like shape and

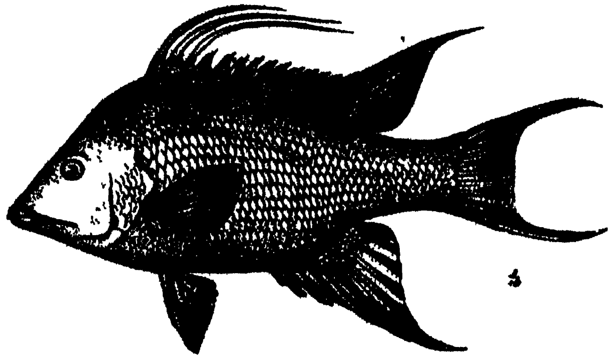

Figure 55.—Hog-fish (*Lachnolaimus maximus*).

snoute (for this is not the old knowen [European] hogge fishe with prickles on his back); the delicate amber fish [*Seriola*], from his taste and smell; angell fish; cony fish, the smale yellowe tayle [*Ocyurus*], from that naturall pointeinge; the great grouper [hamlet grouper, pl. xcv, fig. 2], from his odd and strange gruntinge; with many other kindes, some of them knowen to the Americans only, as the porguise [porgy], the cavallo, the garrfish; the rst in common to them with other continents, as they are in parallel with them, as

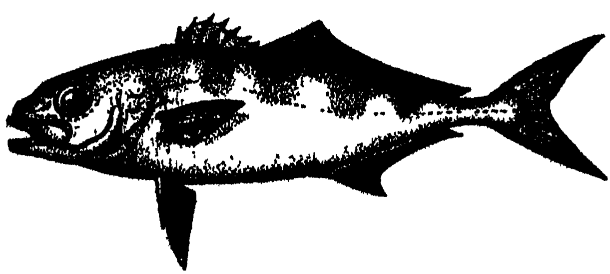

Figure 55*a*.—Amber-fish (*Seriola Dumerelli*), ⅛.

the whale, the sharke, the pilote fish, the sea-breame, the oyster [pearl oyster], the lobster [*Panulirus*, pl. xciv]; and, for the amphybians, the tortoise [sea-turtles], with divers others tedeous to reherse."

Most of the species here named are still called by the same names by the fishermen, both here and in the Bahamas.

We also learn from Governor Butler and Captain Smith, that in the famine of 1614–15 most of the people lived for some two or three months mainly on the fishes that were caught under the guidance of Governor Moore, who made great exertions in this direction.

Governor Butler, in describing the famine, thus alludes to this fishing:

"The people being once againe for the most part all of them at the towne, [after they had been removed from Port Royal] the Governour takes exceedeinge care for their releife, and trimminge up all his botes, manns them with the best and ablest of his men, and so putts them to continuall fishinge for the rest; in so much that ordinarily 150 and sometimes 200 great fishes are brought home in a daye: at last the hookes and lines groweing scarce, he causeth the smithes to make hookes of old rustye swords; and cutting a cable belonging to the pinnace called the Thomas, setts the people on worck to make lines, and oft times would he rise himselfe at midnight, call up his fishermen and sett them out to sea: with which course and by which meanes for two or three monethes wer the people in some convenient fashion kept and maintayned."

We learn other details of this matter from Mr. Hughes and Capt. John Smith, who add that finally these crude hooks and lines gave out, and then there was much suffering and many deaths from disease and starvation.

For a number of years after this, the wild hogs, sea-birds, and sea-turtles having been already mostly destroyed, the fishes furnished a large proportion of their food, and some of these early writers speak of the rapid decrease in their numbers. This decrease in the fishes, due to overfishing, soon attracted the attention of the government. In March, 1627, the Assembly passed the following law:

"An act against the drawing of Pilchards and ffrye to make oyle."

"Whereas it hath bene and still is a usuall Custome of the Inhabitants of theise Islands to hale and draw pilchards in severall bayes and places where they doe frequent, more for the benefitt of the oyle than present use of fishing, to the generall losse of the same Inhabitants, not only by reason of the destroying of very much frye but also to the greate losse and prejudice of the said Inhabitants by chasing away other greate fishe from the shoare, wch live upon the said frye. And further doth hereby cause the said Pilchards and other small fish to be so shie that there is greate scarciety of Bayte for necessary fishing, wch beeing considered by this worthye and grave assemblie. It is enacted by the power and authoritye of the

same. That from henceforth noe manner of pson whatsoever do hale or drawe any pilchards or other frye or small fish (unless for baite or food) out of any of the bayes or other places belonging to these Islands as aforesaid. And the rather for that it is a greate reliefe being taken only for baite to bring in sea fishe, and otherwise a greate losse, especially in tyme of scarceitye of corne. And it is further enacted by the power and authority aforesaid, that noe man of what quality so ever shall hale or drawe in any bay or about any Island wth any long netts any manner of breames, to the distruccon and fraying of the greate fishe from shoare, but only wth netts of Tenn fathom long at the most, in forfeiture of the said netts soe used to be sould, and converted to genrall uses of the plantacon."

Capt. John Smith, in 1629, says that there were "fish enough but not so much near the shore as it used."

A law was passed Jan., 1677, against taking "White-bone Porgaye" when schooling in April and May, except for immediate family use. Modern laws, regulating and restricting the methods of fishing, have been in force for many years, and have, without doubt, been very useful in preserving some of the most valuable fishes.*

Although the records are rather indefinite, there can be no doubt whatever that the larger and more important fishes decreased very rapidly during the first 20 years of the settlement, and probably they continued to decrease more gradually during all the 17th and 18th centuries, because during that time the inhabitants used fish very largely as food, there being but little meat or fish imported. Moreover, there was a considerable fishery carried on in the 18th century for the export trade with the West Indies. The fishes exported are said to have been mostly Hamlet Groupers (*Epinephelus striatus*), but probably various other large fishes were taken for this purpose, especially the several species of Rockfishes (as *Mycteroperca bonaci*, *M. tigris*, *M. falcata*, pl. xcv), and the large Hogfish (*Lachnolaimus maximus*, fig. 55). The latter was evidently very

* During the months of May, June, July, and August, it is illegal to catch any fish with a net of less than a four inch mesh—excepting turtle, cast, or fry nets, the use of which, for their respective purposes, is not prohibited. The catching of Oysters and Scallops is illegal during the same months. Harrington Sound is prohibited water the year round for any other than a cast-net, used to take fish. The selling of Rockfish and Hogfish under 2 lbs.; Porgy and Hamlet under 1 lb.; Shad, Bream, Yellow Grunt, Chub, and Mullet under 5 inches in length is illegal. Turtles (except the Hawksbill) must not be taken if under 10 lbs. in weight, save for the purpose of stocking turtle ponds. The destruction of fish in inland waters by explosives is prohibited.

abundant in the early times, for it gave its name to Hogfish Cut, Hogfish Ledge, and Hogfish Beacon. At present it is by no means abundant, though many of moderate size, the largest weighing 15 to 20 pounds, are still brought to the markets. However, owing to the great extent of the outer reefs, it is not likely that the fishery will be reduced much below its present standard by the methods now practiced.

c.—*The Bermuda Lobster.* (*Panulirus argus.*)

FIGURE 56. PLATE XCIV; FIGURE 1.

Most of the early writers mention the Lobster or Crayfish as abundant, and Strachy says that they could be found under stones, on the shores, indicating that it was far more abundant than at pres-

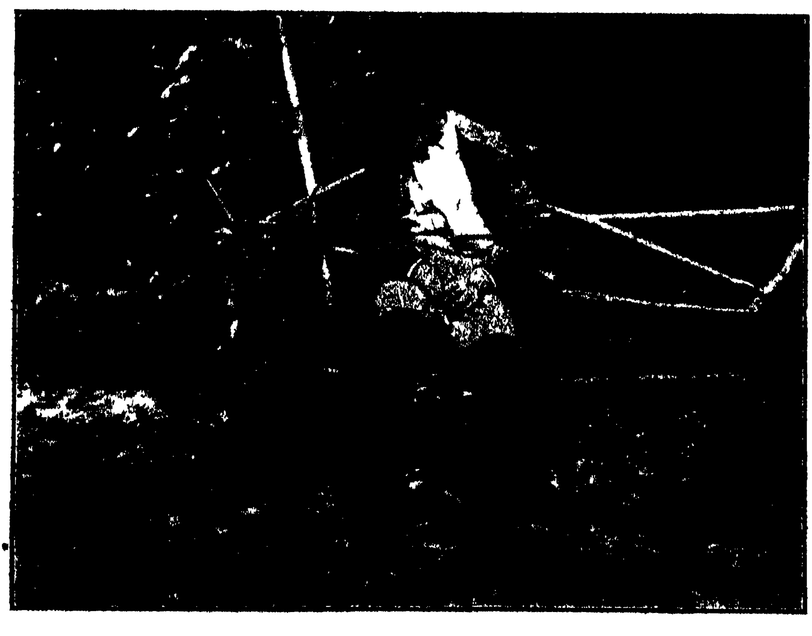

Figure 56.—A large Bermuda Lobster (*Panulirus argus*), and a characteristic Bermuda fish-trap.

ent, though it is still taken in considerable quantities, both in traps and by spearing it. The fish and lobster traps used in Bermuda are rather peculiar in construction, looking like two square crates, united cornerwise, and with the funnel-shaped entrance in the reëntrant angle. (Figure 56.) But the principle involved is the same as

in the simpler New England lobster pots. A skillful person may still obtain many lobsters by quietly rowing along the reefs and rocky shores and spearing those that show themselves in front of their holes or dens, which are under stones or in cavernous places in the reefs. They rarely weigh more than 20 pounds, but most that are taken for the market do not exceed 4 or 5 pounds. As they have no large claws, the weight is much less, in proportion to the size of the body, than in the American lobster. The flavor is equally good, but perhaps rather sweeter

The colors, especially in the young, are bright and striking, the back is greenish, specked with yellow; usually there is a row of two or three large, round, pale, yellowish spots along each side of the back of the abdomen ; the telson and caudal appendages are handsomely banded near the borders with black and white ; the legs are light blue, whitish below.

The decrease in the numbers of the large and voracious fishes, like the groupers and rockfishes, would naturally have had a tendency to cause an increase in the number of lobsters, for those fishes and many others depended upon the lobsters for a part of their food. This, in a measure, has counteracted the effects of the lobster fishermen. Owing to the absence of claws the Bermuda lobster is a very helpless and timid creature, depending for safety upon quickly retreating into its holes on the approach of an enemy. It has great fear of the Octopus, which often captures it.

d.—The Land Crabs. (*Gecarcinus lateralis* Frem., etc.)

FIGURE 57.

The Land Crabs were mentioned by Capt. John Smith as very abundant and injurious, "As thick in their Burrows as conies in a Warren and doe much hurt."

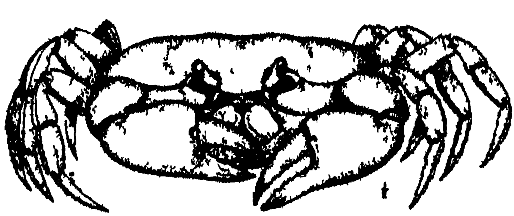

Figure 57 —Land Crab. (*Gecarcinus lateralis.*)

Complaints were also made that persons in digging them for bait trespassed on the lands of others and did much damage by digging large holes, so that an early law was passed to prevent that evil.

No mention is made of its being used as food, except in one instance, by Capt. Smith (see under Whelk). This may, however, have been common in times of scarcity, for the land crabs are much eaten in the West Indies, by the natives.

This smaller land crab is still common enough in certain barren and sandy localities, as at Tucker's Town, and especially on the smaller uninhabited islands, wherever there is sandy soil, but it is evidently far less abundant than formerly. Probably the introduction of poultry was an important cause of this decrease, for turkeys, chickens, and other species will greedily devour the young crabs. The adult crabs often make a burrow three or four feet deep and six to seven feet long. These are often situated among the matted roots of cedars, or between and under large rocks, so that they are very secure. The living specimens are reddish brown or chocolate-brown above.

The great Land Crab (*Cardisoma Guanhumi* Lat.) is comparatively rare. It is often 16 to 18 inches across its outstretched legs, with the carapax three to four inches across It makes very large and deep holes. We saw a number of these holes at Hungry Bay, among the roots of cedars, where they could not be dug out without great labor. It also occurs on Cooper's Island, whence I have a specimen sent by J. M. Jones, many years ago. Mr. Moseley obtained specimens by using torches at night, which we did not have an opportunity to try. This species was probably much more abundant formerly than at present.

e.—The Devil Fish; Octopus; "Scuttle." (*Octopus rugosus* Bosc).

PLATE XCIV, FIGURE 2

This large octopus is by no means uncommon, but the fishermen claim that it was formerly more abundant. The decrease in the large Rockfishes and Groupers that feed on the Octopus would seem to have favored its increase, but on the other hand, it is taken by the fishermen in considerable numbers for bait, by the use of grains. It is sometimes eaten by the natives, but probably to no great extent, owing to the abundance of excellent fishes. I am not aware that it is ever brought to the market, as it is in many other countries. The largest are said to have weighed 40 to 50 pounds, with arms 7 or 8 feet long. The largest that we caught by hand were only about five feet across the outstretched arms.*

* We captured about a dozen by hand, in shallow water, suddenly grabbing them around the neck and holding them firmly till their violent struggles were subdued. They make a lively fight for a short time.

f.—Gastropods: Whelks; Conchs, etc.

The "Wilk," or West Indian Whelk. (*Livona pica*) See p. 464, figure 22*a*.

This mollusk was apparently referred to by Strachy in 1610, under the name of Wilke: "We have taken also from under the broken Rockes, Crevises,* oftentimes greater than any of our best English Lobsters; and likewise abundance of Crabbes, Oysters [Pearl oysters], and Wilkes."

Capt. John Smith, describing the famine of 1614–15, says: "One amongst the rest hid himself in the woods, and lived only on Wilkes and Land Crabs, fat and lusty, many moneths."

Henry May mentioned that they burned the shells of "wilkes" and pieces of limestone to make cement for the seams of their vessel, by mixing the lime with turtle oil.

These and other incidental allusions to the "wilk," render it probable that this mollusk, still known as "the whelk" or "wilk" in the West Indies, and used there in many places as food, was abundant at the time of the settlement of Bermuda and was used as food, more or less. It is a shallow water species, with a large conspicuous shell, and therefore easily taken.

But no living specimens have ever been found here in modern times,† so far as recorded, nor could I learn that any had been taken within the memory of the oldest inhabitants. However, its shells are abundant as fossils in the sand dunes and in the æolian limestones all over the islands, where they had doubtless been carried on the backs of the land hermit crabs (*Cenobita diogenes*, see fig. 22*a*, p. 464). At present these same crabs again utilize the old fossil shells, when they find them weathered out and scattered loose on the surface, as they often are.

We also dredged up two dead, but perfect, specimens from about ten feet of water, in "The Reach," at St. George's, but they may have been buried under the calcareous mud many years, without showing much alteration.

Somewhat better evidence was obtained by digging in the kitchen middens at Castle Island, probably deposited about 1812, in which we found a few broken but unaltered shells of this species, looking as if they had been broken to extract the meats.

* This is the Bermuda Lobster (*Panulirus argus*), still common, but now rarely found under the stones on the shore.

† During our visit in 1901, a large number of these "whelks," brought alive from the Bahamas, were liberated in Hamilton Harbor, by Mr. Roberts, so it may become naturalized here.

It is probable, therefore, that this was a species formerly common, but exterminated by the settlers for food. Probably it was rare even in 1812, otherwise there would have been more shells in the kitchen middens. The last of the race may have been exterminated by the soldiers in 1812, or perhaps by some natural cause, about that time.

The Great Conch or *Pink Conch.* (*Strombus gigas.*)

The large pink conch has, in recent times, been so extensively fished for sale to visitors that its numbers have very much decreased, though some are still taken in a few places. One of its localities is in Castle Harbor, about half a mile north of Castle Island ; another is in Great Harbor.

The Trumpet Shell (*Triton variegatus.*)

This large shell has also become rare in these waters, only a few scattering specimens being now found.

The Spotted Cowrie. (*Cypræa exanthema.*)

This handsome shell has also become very rare, like several others that are caught for sale as curiosities. Some of the specimens formerly taken were of great size and very handsomely colored. I have seen some that were 4½ inches or more in length.

g.—Bivalves: Scallops; Oysters, etc.

The Scallop. (*Pecten ziczac* Lam.)

This large scallop is still found in small numbers in certain parts of Harrington Sound and in a few other localities, but is said to be much less abundant than formerly. Its flesh (adductor muscle) is well flavored and it is, therefore, much in demand.

The Oyster; Pearl Oyster. (*Margaritophora radiata* Lam.)

The so-called oyster of Bermuda is not a real oyster, but is a true pearl oyster, smaller in size than most of the pearl oysters of the Pacific and Indian oceans. It is, however, used to a considerable extent as food, but is neither so tender nor so palatable as the American oyster, nor does it contain so much nutritive material. It is still fairly abundant in certain parts of Harrington Sound and many other places, but is said to be less abundant and smaller than formerly, owing to overfishing.

In the early days of Bermuda, the settlers and the Company had great hopes of finding valuable pearls in these shells, but though

some were obtained, they were so few and small that the search was soon abandoned as unprofitable.

Silvanus Jourdan wrote as follows: "There is great store of Pearle and some of them very fair round and orientall, and you shall find at least one hundred seede pearle* in one oyster."

The Mussle. (*Arca Noæ* L.)

It is curious that the name "mussle" should have been transferred to this shell, which is fished up in considerable quantities for food. It is mostly obtained by means of "nippers" in shallow water, for it often grows in large clusters, firmly attached to rocks, etc., and to each other, by a very strong byssus. Usually it is intermixed with "oysters" in the clusters. It is still abundant in Harrington Sound and many other places, and perhaps it has not decreased to any great extent. It is not particularly well flavored and is rather tough, and therefore is not in much demand.

A true mussle (*Modiola tulipa*), large enough for the market, is also found here, but I could not learn that it is caught for food, nor does it seem to be abundant.

The "rock cockles" (*Chama*, sp. and *Spondylus*, sp.) are sometimes collected to some extent for food, but not regularly. They are fairly well flavored, as I ascertained by trial.

Some of the large species of *Tellina* are also used as food under the name of "clams." But the large and common bivalve called "Spanish Clam" (*Codakia tigrina*) is considered poisonous.

33.—*Introduction of Domestic Animals.*

a.—The Wild Hogs. (See p. 589.)

In a previous chapter the introduction of the wild hogs has been described as probably due to pirates or buccaneers who visited the islands in the 16th century, rather than to the accidents of shipwrecks, for in case of shipwrecks any hogs that might have been saved would probably have been afterwards killed and eaten by the people who escaped. The chances of hogs escaping from a total wreck on the distant reefs would be very small.

Henry May and his party, in 1593, found them there. He said: "In the South part of this Island of Bermuda there are hogs, but they are so leane that you cannot eat them, by reason the Island is so barren, but it yieldeth great store of fowle, fish and tortoises."

* It seems from another account that this referred to a single lucky find, which was not repeated.

This was probably on St. George's where they landed, and the season was unfavorable for the hogs. There must have been a long period of famine for the hogs every winter, after the cedar and palmetto berries were all gone, for at that time, and perhaps partly in consequence of their previous ravages (see p. 589), there were but few other edible plants for them on the islands, though they could always find more or less food cast up by the sea on the beaches.

Silvanus Jourdan stated that Sir George Somers sometimes took 32 hogs in one day. His party of 150, who lived nine months on the islands, not only depended largely on the hogs for food, but also took a supply of the dried flesh to Virginia. But they also took pains to gather food to fatten them in confinement.

Strachy gave the following graphic account of the wild hogs as they existed in 1609:—

"Wee had knowledge that there were wilde Hogges upon the Iland, at first by our owne Swine preserved from the wrack and brought to shoare: for they straying into the woods, an huge wilde Boare followed downe to our quarter, which at night was watched and taken in this sort. One of Sir George Summer's men went and lay among the Swine, when the Boare being come and groveled by the Sowes, hee put over his hand and rubbed the side gently of the Boare, which then lay still, by which meanes hee fastened a rope with a sliding knot to the hinder legge and so tooke him, and after him in this sort two or three more. But in the end (a little businesse over) our people would goe a hunting with our Ship Dogge, and sometimes bring home thirtie, sometimes fiftie Boares, Sowes, and Pigs in a weeke alive; for the Dog would fasten on them and hold, whilest the Hunts-men made in: and there bee thousands of them in the Ilands, and at that time of the yeere, in August, September, October, and November, they were well fed with Berries that dropped from the Cedars and the Palmes, and in our quarter wee made styes for them, and gathering of these Berries served them twice a day, by which meanes we kept them in good plight; and when there was any fret of weather (for upon every increase of wind the billow would be so great, as it was no putting out with our Gundall or Canow) that we could not fish nor take Tortoyses, then wee killed our Hogs.

But in February when the Palme Berries began to be scant or dry and the Cedar Berries failed two months sooner, true it is the Hogs grew poore, and being taken so, wee could not raise them to be better for besides those Berries, we had nothing wherewith to franke them."

In Governor Moore's report, of 1612, the following occurs:

"Some sixe days after our coming, [July] we sent out for Hogges, so the company which went out brought home some. I hould your mutton of England not of so sweet and pleasant a taste.".

Hughes, in 1614, wrote as follows:

"Here is no kinde of beasts but hogges and cattes and they but in one or two places which are thought to come at first by meanes of shippe-wracke. The hogges were manie but are now brought to a small number."

The wild hogs were probably nearly all exterminated within the next two or three years; indeed it is probable that most of them were killed in 1614 and 1615, during the partial famines that then prevailed among the settlers. Governor Butler, in 1619, wrote that there were then "some fewe wild." Probably many of the wild ones were taken alive and kept as domestic hogs.

But tame hogs were also taken there from England by the early settlers, in 1612–16, and increased very rapidly, as soon as corn and other food could be provided for them in winter, so that Governor Butler, in 1619, said that they were "in great numbers." Figs were used, a little later, to fatten the hogs. (See p. 681.) Ever since that time hogs have been abundant.

b.—The Plague of Wood Rats. (*Mus tectorum* Savi.) See p. 590.

It was generally believed by the early writers, but without sufficient reasons, that this very destructive rodent was first brought to Bermuda about January, 1614, in the runaway frigate commanded by Capt. Daniel Elfred, but the name of the frigate was not given. She arrived two months before the "Blessinge," and thus relieved the famine which then prevailed.

This was largely due to the fact that the earlier visitors did not notice any rats. Thus Silvanus Jourdan, 1610, says: "The countrey (foreasmuch as I could finde myself, or heare by others) affords no venimous creature or so much as a Rat or a mouse, or any other thing unwholesome."

But such writers were not likely to have noticed a strictly nocturnal species like this, which at that time was confined to the cedar forests.

Governor Butler, in speaking of this arrival, wrote as follows:

"But howsoever this runne away frigate brought with her a timely and acceptable sacrifice of her meale; yet the companions of

her meale, numbers of ratts (which wer the first that the ilands ever sawe), being received with-all and on a soudaine multiplyinge themselves by an infinite increase (for ther is noe place in the world so proper for them), within the space of one only yeare they became so terrible to the poore inhabitants, as that (like one of Pharaoths plagues) the whole plantation was almost utterly subverted therby; and so farr gone it was at last, that it proved Captaine Tucker's masterpiece all his time (which was not long after) to devise trapps and stratagems to conquer and destroye them, though indeed all of them proved to noe purpose (as you shall see hereafter) untill afterwards, one moneth of cold and wett weather [probably March, 1618] did the deed."

In a later chapter he gave many additional details. He, like Hughes, attributed the death of the rats mainly to a spell of cold rainy weather, but this was, of course, derived from the statements of others, for it happened before his arrival there. Other writers denied that the weather had been any colder than on various other occasions. His fuller account is as follows:

"Sone after the conclusion of this assize [March, 1618] came a hotte alarme from Sands his tribe, of a fierce assault made by the ratts upon their new sette corne, who scratched it out of the ground in the night as fast as they put it in in the day; thes race of ratts being (as you have heard) first brought in by the runne away frigate from the West Indies, in Mr. Moores time, began presently so sylently and sodainely to encrease (ther being noe place of the world more apt to nourish them, partly by reason of the sweet temper of the aire, but especially through the general shelter and covert that it affords them) that they then became felt before they wer feared, and yet not so duely feared as befitted; so that little or noethinge being done against them at that time, and lesse in the lazie dayes of the six Governours [1615–16], they wer by this time gotten to so ranck a head that swimeinge in huge troupes from iland to iland (for fishes have bin taken three leagues of at sea with whole ratts in their bellyes), they eate up the whole country before them, wheresoever they went, utterly devoureinge all the corne they mett with all in an instant; so that, in despight of all the catts sent from out of England, and the layeinges of poyson, the Governours often fireinge of the whole ilands, to the huge waste and spoyle of much excellent cædar timber, or whatsoever els could be devised against them, they every day more and more so multiplied and grew upon the poore amazed people, as that it very little wanted that the

whole place had once againe bin utterly and quite left voide of her reasonable inhabitants: and with out all question, this ill had not fayled to have befallen, had not God (who noe doubt hath an especiall worck in the peopling of thes partes with Christians), by his owne hand, in great mercy, swept them all away in an instant, when it was least expected; for not long after that the Governour (having thus received this loathed report of this ratt-warre in Somersett, and being at his non-plus of newe devises to helpe himselfe), had determined once againe to fall upon another generall burneinge of the whole ilands, to the extreame discontent of all men, and especially of Mr. Lewes [Hughes] the minister, who openly preached against it, so that the Governour could never endure him afterwards; behold by a soudaine fall of a great store of raine, and some cold northerly windes bloweinge with all, in a moment, and when noe man durst so much as hope for so happy a turne, thes mightie armies of ravenous ratts are clean taken awaye, vanish, and are scarce one to be found in a share; but in steed of them, shortly after, come in marchinge towards the houses, whole troupes of great and fatte wild catts, who havienge formerly found foode ynough upon these vermin abroad, and so become wild and savage, are now againe in this their necessitie, and by want of wonted reliefe, forced to returne to their first tamenesse."

The Rev. Mr. Hughes, who was present during part of the time, gave the following account:

"Let not the hand of God, which lay heavy upon you in Captain Tucker's time [1616–18], be forgotten, when the rats did abound, and goe by sea from Iland to Iland, so as no Iland was free, but all were like so many Coney-warrens: I say they went by sea from Iland to Iland, because fishes have at divers times been taken three leagues off at sea, with Rats in their mawes, which sheweth plainly that the Rats did swim, and were snapt up of the Fishes. Consider what a plague of God they were unto you both within dores and without: within they devoured your Corne and other provision of foode, and your cloathes and shooes (as myselfe has good cause to remember:) without, they devoured your corne by scraping it out of the ground, when it was new set, the grains which were thrust in so deepe as they could not scrape [rotted], untill God in mercy hearing our poore prayers, tooke them away, on the sodaine in three or foure dayes. I mention the time, because I took good notice of it. As soon as the Rats were destroyed wild Cats, that were neither seene nor knowne to be in any such abundance, came marching out

of the woods, to your houses, six, seven, or eight in a company: then it was in every bodie's mouth, that the Cats had destroyed the Rats, and some said that the coldnesse of Winter killed them. I remember indeede that we had a very colde time a little before they were destroyed, which, (I am persuaded) God in mercy did send for the killing of them, nor (as some doe) to the Traps, nor to the ruinating of the Islands with fire; and take heede that your unthankfulness bring them not againe, or some other plague as bad."

Capt. John Smith, in his General History, 1624, gave a detailed account of these rats, compiled chiefly from the works of Butler and Hughes, but with a few additions from other sources.* Among other items he stated that every man was enjoyned to set twelve traps and some set nearly a hundred, which they visited twice each night, and that they used ratsbane, and both cats and dogs in large numbers, setting fire, and various other devices, "but could not prevaile, finding them still increasing against them; nay they so devoured the fruits of the earth that they were destitute of bread for a year or two." He also discussed the various supposed causes of their sudden death, and objected to the theory that it was due to cold, for he said that "they wanted not the feathers of young birds and chickens which they daily killed, and Palmetto mosse to builde themselves warm nests out of the wind; as usually they did;† neither doth it appeare that the cold was so mortal to them, seeing they would ordinarily swimme from place to place, and bee very fat even in the midst of winter." He concluded, therefore, that "there was joyned with and besides the ordinary and manifest meanes, a more mediate and secret work of God."

The real cause of their sudden disappearance, as mentioned above (p. 590) was, in all probability, *starvation*,‡ after they had destroyed all available sources of food, in consequence of their vast increase. This disappearance of food, in the winter, would necessarily cause their sudden death, "all in three or four days," as Mr. Hughes stated. A very few, however, seem to have survived, for they have

* His account has been copied entire in Lefroy's Memorials, I, and by J. M. Jones, in Bull 25, U. S. Nat. Mus., p. 158 Therefore I have not repeated it here, but only give the facts supplementary to the others.

† In another place he says the nests were built in trees, thus proving that it was the wood-rat.

‡ It is curious that their starvation was not thought of as the actual cause of their death, neither by the early writers nor by Jones and others who have discussed this subject in modern times, especially as Hughes and others recognised the potency of starvation in the case of the cats and hogs.

been found there in recent times, in small numbers.* They are now probably kept down to small numbers by the gray rats, which are now common, even in the woods and fields, as we learned by trapping them in 1901. We did not succeed in taking wood-rats, but that may have been because we did not have an opportunity to set traps in the thick swamps, to which they are mainly confined, it is said. But most of the planters, who were questioned, claimed that they had never seen such a rat. Therefore it is probably local and not in any large numbers. Matthew Jones, 1884, fully describes the nests found in cedar trees, and sometimes in low bushes in the swamps. He states that they are spherical and about a foot in diameter, lined with soft materials. Mr. Hurdis also mentions finding this species in 1850, but says he met with it only once in fourteen years, and never saw the nest. Jones says that they did much damage to the oranges. In 1898, I saw bananas damaged on the trees by rats, as the owners said; and very likely by this species, though the more common brown rat might also ascend the banana stalks.

As for the time and mode of introduction of this species, it seems to me impossible to believe that it was first taken there by the frigate, in 1614. This frigate might have had some of these rats on board, but she was more likely to have had the common domestic rats, which may have escaped to the shores and thus gave rise to the notion that the subsequent rat plague was due to them.

But the vast numbers in which the wood-rat appeared a year or two later (one year according to Butler) cannot by any possibility be explained by the natural increase from any number likely to have been contained in any one ship; for there must have been tens of thousands of them, and that in spite of the numerous wild and half-wild cats then on the islands. Probably these rats had found their way to the islands at a much earlier period, either by shipwrecked vessels from the West Indies, or by the buccaneers landing there. They may have been introduced at the same time as the wild hogs. It is also possible that they might have been introduced by the shipwreck of the Bonaventura, in 1593, for they are such good swimmers that they could easily have reached the land from the wreck at North Rocks. Even in the latter case they would have had 21 years to increase before they attracted attention by their numbers. I am more inclined to believe that they were introduced even earlier than that.

* Butler stated that a very few were left in his time, 1621.

As they are very nocturnal in their habits and inhabit by preference the thick woods and swamps, it is not strange that the early writers did not observe them, even if common. But after the settlers began to plant corn and other crops and fruits attractive to these rats, they naturally began to collect around the plantations and storehouses in large numbers, especially in winter and spring, when their natural food was scarce, and thus forced themselves into notice at once. At the same time this new source of supply of food in the winter would have prevented the death of large numbers by starvation, as may have occurred previously on many occasions, for their sources of food supply, like those of the hogs, were very limited at that season, for lack of native edible plants and seeds. (See pp. 589, 590.)

The Wood-rat can easily be distinguished from the other rats by having a more hairy and less scaly tail, and especially by the pure white, or nearly white, color of its under parts, while its back is light chestnut-brown. It is smaller than the brown rat, and not so stout. It is a native of the warmer parts of the Old World, but was early introduced into the West Indies, Central America, and the southern United States.

c.—Common Rats and Mice; Bats.

The Brown or Gray Rat (*Mus decumanus* Pallas) and the mouse (*M. musculus* L.) are very common in Bermuda, both in and about the buildings and in the woods and fields, far away from houses. We have no positive data as to when they were introduced, but the mouse was probably there in the early years of the settlement. The Gray Rat probably did not arrive till the middle of the 18th century or later.

The Black Rat (*Mus rattus* L.) was formerly very common, but has been largely exterminated by the brown rat, which arrived later, as in most other places in America. Hurdis states that it was common about 1850. Jones, 1884, states that it was rare. This rat, like the mouse, was probably introduced from Europe with the early settlers, or from the West Indies on the "runaway frigate," in 1614. There are no native land mammals* in Bermuda, except a few migrating North American bats.

* J. M. Jones thought that he had seen a shrew, 1876, but it has not been seen by others.

A single specimen of a seal, supposed to be *Phoca vitulina*, was taken in April, 1887. Its skin was preserved by Bartram, and is still extant, but I did not see it. Bartram recorded its capture in the Royal Gazette, at the time. It was also noticed by Hurdis (Rough Notes, p. 340). No other instance is known. It might be the young of the West Indian Seal.

Two species of bats are known to occur here apparently during their autumnal migrations, but yet they may have been brought in the holds of vessels. Others may hereafter be observed. The most common is the Hoary or Gray Bat (*Atalapha cinerea* (Beauv.) Peters; Allen,* p. 155, pl. xxix–xxxi = *Vespertilio pruinosus* Say, and in Jones, 1876, and Hurdis = *Lasiurus cinereus* in Jones, 1884). Several instances of the occurrence of this species are given by Hurdis and others, but only in autumn.

The other, which is much more rare, is the Silver-haired Bat (*Lasionyteris noctivagans* (Lec.) Peters; Allen, 1893, p. 105, pl. xii; xiv = *Scotophilus noctivagans* in Jones, 1884). This was recorded as taken alive by Hurdis, Oct. 8, 1850.

It is singular that there are no native bats known here, for the numerous caves would seem to afford excellent homes for them. Some of the earliest writers mention the occurrence of bats, but they were probably only the migratory species named above, though the season of the year was not given. Possibly there were resident species at that time.

d.—The Wild or Half-wild Cats.

In the accounts quoted above, Strachy, Hughes, and Governor Butler (pp. 712–715) describe the great abundance of feral cats that came out of the wood to the settlements, when the rats died out, as an unexpected and surprising event. They evidently believed that the cats had been on the islands before the settlement in 1612, and that they had been living there in the feral condition, feeding on the rats. This may have been correct, and if so it would go to prove that the rats had also been there longer than was then supposed.

It is mentioned that the party shipwrecked there in 1609 saved their ship dog and also some live hogs. (See Strachy's account, quoted above.) Therefore they probably also saved their cats, if they had any, which is almost certain to have been the case. These cats escaping into the woods and increasing as they do there, might have given rise, in the nine years, to the large number observed in 1618. Possibly cats may have been introduced still earlier, like the hogs, but we have no record of any being there in 1609. Doubtless the settlers carried cats there in 1612, and perhaps every year afterwards, so that their numbers need not have been surprising.

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* Harrison Allen, M.D., Monograph of the Bats of North America, Bulletin U. S. National Museum, No. 43, 1893.

e.—Cattle and other Domestic Animals.

A few cattle, goats, sheep, and English rabbits or coneys were sent over very soon after the settlement, in 1612, but these first importations were probably mostly, if not all, destroyed during the famine of 1615. Governor Butler, as mentioned above, stated that the lazy people then colonized at Port Royal, rather than to fish, killed for food the few cattle then existing and pretended to the Governor that they ran into the sea and were drowned. But probably other cattle were sent out by nearly every magazine ship, for several years, till they increased naturally and became common.

Governor Butler mentioned that Governor Tucker, in 1616, was engaged in building fences, to protect his introduced plants against domestic animals, and stated that the cattle had been sent partly by the general Company, but mostly by the Earl of Warwick.

Governor Butler, in 1619, also wrote as follows:

"As for the beasts of the field,—cowes and bulls ther are which prosper exceedingly; hogges (wherof some fewe wilde) in great numbers; Indian and English goates likewise, but of noe great hope, for (like the pigeons) they are also found dead and dieinge in every corner;* and lastly, there are a late great increase of tame conyes, the which, being reserved in certaine empaled places about the houses, are ther fedd with the potatoe slipps and other simples native of the place, the which they eate very greedely; they fare well withall."

Sheep do not appear to have been kept in large numbers, at any time. Probably they did not thrive very well, as in most hot climates. But Hughes, in 1615, says:

"The Calves and Lambes that we brought out of England, did prosper exceedingly, till the hunters met with them."

f.—Horses.

I can find no record of the arrival of horses, mules, or asses in the early years, nor any mention of their presence there for many years later. The narrowness of the highways and of the early streets in St. George's indicates that horses and carriages were not commonly used there till long after the settlement. Probably the earliest horses were only used for horseback riding, by the more wealthy

* Doubtless due to poisonous plants that they ate, including tobacco. (See p. 593.) At the present time goats are common enough.

people. The general use of boats for the transportation of goods and persons rendered horses of less importance than in most places. Horses, however, must have become somewhat common by 1672, for some of the militia men were mounted, and orders were given to have the horses trained so that they would stand the noise of drums and the discharge of firearms.

34.—*Introduction of Birds.*

a.—Poultry.

Domestic poultry, including turkeys, were probably introduced by the earliest settlers, in 1612, and became abundant in a few years, though Governor Butler stated that the geese and pigeons, like goats, did not succeed very well at first. But probably this was only a temporary drawback, due to unaccustomed food.

Governor Butler, 1619, mentions the poultry, as follows:

"And thes are the natives of the ayre; to which have bin added, by the late inhabitants, great store of turkeys and abundance of cocks and hens, which every daye growe wilde; numbers of tame chicks, and some fewe geese and house pigeons; but thes last two like not so well, for by some disagreeinge foode they kill themselves."

Probably some of the native fruits and seeds, which they had not then learned to avoid, were poisonous to these fowls.*

The Rev. Mr. Hughes, 1614, says:

"The cocks and hennes wee brought with us doe prosper and increase much, and are a great comfort unto us."

Ducks and the Guinea Fowl or Pintado were introduced later, as also the Peacock, etc.

Mr. Hurdis (p. 407) also mentions the South American Powee or Crested Curassow, as not uncommon in his time, kept with other poultry as an ornamental bird.

Domestic Pigeons at certain periods appear to have become half wild, and are said to have nested in holes and caverns of the cliffs. One locality is still called Pigeon Cave. At present they are not abundant, so far as we observed.

* Mr. Hurdis, Rough Notes, p. 308, states that he repeatedly tried, without success, to keep imported fowls bought from vessels, but they invariably died very soon, though the native ones were perfectly healthy. Some of the people complained to us that the Octopus often seized and killed their ducks and geese.

b.—Game Birds, etc.

The American Quail or Bobwhite. (*Colinus Virginianus* (L.) Les.)

FIGURE 58.

The early writers do not mention any bird of this sort, therefore it is altogether probable that the Quails said to have been found here in the wild state more than sixty years ago were introduced by some enterprising person at an earlier period, but of this no record is known to me. Possibly some governor or army officer fond of shooting game may have done this.* But it seems to have become extinct

Figure 58.—American Quail or Bobwhite (*Colinus Virginianus* (L.) Les.)

Figure 59.—Mocking Bird (*Mimus polyglottos* (L.) Brewer = *M. Carolinensis* Cab.) Both from Webster's International Dictionary.

here before 1840. Mr. Hurdis, during his entire residence, 1840 to 1855, did not meet with it. It was subsequently introduced again, by Mr. Richard Darrell, about 1858 or 59, according to Capt. Reid, and having been better protected by the modern game laws it has become common for the past twenty-five years or more. It not infrequently comes into the poultry yards and feeds with the chickens, as I have personally observed.

The English Pheasant and Partridge were introduced in 1877 by Governor Robert M. Laffan, according to Hurdis (p. 407), but whether either of them long survived I do not know; they certainly had not become common in 1901, if present at all, which I doubt.

* References to the birds of Bermuda are practically wholly lacking in the literature from 1650 to 1850.

Bahama Ground-dove. (*Columbigallina passerina* (L.) Bry., *Bahamensis* Mayard).*

FIGURE 10. PAGE 480

The early writers mention no bird corresponding to this, which, owing to its very familiar habits, would surely have been noticed had it been present in any numbers. Therefore it seems altogether probable that it was introduced from the Bahamas like large numbers of the plants, but we have no record of the time or manner of its introduction. It is mentioned as very common in the earliest of the modern lists of birds (1850, 1851). For about 200 years previously, however, there is scarcely anything recorded concerning the birds of Bermuda. It may have been introduced in the 18th century, which would account for its present abundance. It does not appear to differ from the Bahama form, even as a variety.

c.—*Singing Birds.*

Mocking Bird. (*Mimus polyglottos* (L.) Brewer=*M. Carolinensis* Cab.)

FIGURE 59.

A few individuals of this species seem to have been introduced at several dates One instance was at Bailey Bay, in 1892. Six pairs are said to have been liberated at St. George's, in 1893, by Capt. Myers, but I have seen no record of the locality from whence they came.

It has increased very slowly and is still far from common, though often seen in a few localities. It seems to be more fond of the Walsingham region than any other. It seems strange that it has not increased more rapidly, as it has few enemies, unless the English Sparrows or Catbirds destroy its eggs. Some of the West Indian Mocking Birds, as *M. orpheus*, etc. might be better adapted for the locality.

English Sparrow. (*Passer domesticus* (L.) Koch.)

The European sparrow was introduced here in 1875, as previously into the United States, under the impression that it would prove very beneficial by destroying insects, which it has not done to any

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* It was first identified as the Bahama subspecies by Mr. A. Hyatt Verrill (Amer. Journ. Science, xii, pp. 64–90, and The Osprey, v, June, 1901, p. 83). Mr. Bangs described it, about the same time, but apparently a few days later, as a new species (*C. Bermudiana*) in the Auk, July, 1901. See also this vol., p. 58, for discussion of dates.

appreciable extent. It has, however, become very abundant and familiar in all parts of the islands and does considerable damage to fruits and in other ways, so that it is generally considered a nuisance. It does not confine itself so much to the settlements and highways as in the United States, but is seen everywhere in the fields and woods. It is accused of destroying the eggs of other more useful birds, as with us. The Bluebird, especially, is said to suffer thus from its depredations. In 1883, an act was passed "To encourage the destruction of Sparrows." But this did not seem to cause any apparent decrease in its numbers, though the amount paid in bounties is said to have been £800 in one year. It was introduced into Bermuda from the United States in 1875.

European Tree-Sparrow. (*Passer montanus* (L.) Koch.)

This bird is apparently not uncommon. It was probably introduced accidentally with the English Sparrow and has similar habits, but it is less familiar. It was first recorded by A. H. Verrill, who found it common in Paget Parish, March, 1901.*

Figure 60.—European Goldfinch (*Carduelis carduelis* (L.) Schäf.) Phot. from life by A. H. Verrill.

European Goldfinch. (*Carduelis carduelis* (L.) Schäf.)

FIGURE 60.

This elegant little bird is becoming quite common in certain localities and seems to be fully naturalized. Numerous specimens were seen in 1901, especially about Hungry Bay.

* Amer. Jour. Science, xii, p. 64, July, 1901; and The Osprey, July, 1901.

It was recorded by Capt. Reid (1884), as seen in a single instance in 1875. He thought that it might have been an escaped cage-bird, but it is not improbable that efforts had been made before that to introduce it here. A considerable number of cage-birds of this and other species are said to have escaped from a wrecked vessel, near St. George's, about 1885, and the recent increase is supposed to be due largely to that event.

American Goldfinch. (*Astragalinus tristis* (L.) Cab. = *Spinus tristis* Boie.)

FIGURE 61.

This was also seen, in March, 1901, and is said to have been introduced intentionally, in 1896, although it may have come here previously, from time to time, as a migrant. Hurdis mentions a small flock of yellow birds, supposed to have been of this species, seen in March, 1850, but not shot.

European Wheat-ear. (*Saxicola œnanthe* Bech.)

This bird is now common in some places and seems to be fully naturalized.

It was seen in flocks, especially at Coney Island and near St. George's. It is said to have escaped from the wrecked vessel, about 1885, like the Goldfinch.

European Starling. (*Sturnus vulgaris* L.)

FIGURE 62.

Several wild specimens of starlings have been observed at different times, and it may now be sparingly naturalized Perhaps it escaped from the wrecked vessel, about 1885, with the Goldfinch and other cage-birds.

Figure 61.—American Goldfinch (*Astragalinus tristis* Cab)

Figure 62.—European Starling (*Sturnus vulgaris* L.)

European Skylark. (*Alauda arvensis* L.)

Hurdis recorded the occurrence of the Skylark, June 12, 1850. He shot one male specimen which had the song, habits, and appearance of a wild bird. It has not been recorded by recent collectors.

Note.—The following are the principal works on the birds of Bermuda:

William Jardine.—Contributions to Ornithology. Ornithology of the Bermudas. Vol. for 1849, pp. 76-87; vol. for 1850, pp. 5-14, 35-38, 67. Gives lists of birds furnished by Lieut-Col. J. W. Wedderburn and Rev. H. B. Tristram, supplemented by the observations of Col. H. M. Drummond-Hay and Mr. J. L. Hurdis. "Mr. Tristram, (who lived in Bermuda three years,) printed a list in the islands, of all the birds that had occurred to his notice in 1847," p. 77. In 1849 twenty species were added, and one in 1850.

John L. Hurdis.—Birds of Bermuda, in the Bermuda Pocket Almanac for 1851, pp. 65-68. A list of 124 species, with 11 others regarded as doubtful. (Published without the name of the author, but as it agrees closely with the list in "Rough Notes," p. 303, it was doubtless by Hurdis.)

John L. Hurdis.—Rough Notes and Memoranda relating to the Natural History of the Bermudas. London, 1897. Edited by H. J. Hurdis from MSS. notes mostly made from 1847-55, relating chiefly to birds, but including some on mammals, fishes, insects, botany, etc.

J. M. Jones.—The Visitor's Guide to Bermuda. Halifax, 1876. Contains a list of birds, pp. 123-130, including those contributed by Hurdis, Reid, and others.

G. Saville Reid.—The Birds of the Bermudas. Printed in The Zoologist for October and November, 1877. (Revised and corrected with additions by Lieut. H. Denison.) Reprinted, with an Appendix (pamphlet 48 pages). Royal Gazette Office. Hamilton, 1883. Originally published in "The Field," 10 numbers, July to September, 1875 This paper contains much information concerning the habits of the birds observed, especially of the game birds.

G. Saville Reid.—The Birds of Bermuda. Bulletin U. S. Nat. Museum. No. 25, 1884. In this paper the previous lists are revised and some additions are made, while many references to the literature are included. The observations of Hurdis are also mostly included in this paper, for the author had the use of his original MSS. notes. Lieut. (later Capt.) Reid was stationed at Bermuda, from March 30, 1874 to June 3, 1875.

D. Webster Prentiss.—Notes on the Birds of Bermuda. The Auk, vol. xiii, p. 237, 1896.

A. H. Verrill.—Amer. Journ. Science, xii, pp. 64-90, for July, 1901 (issued June 26); also The Osprey, v, for June, 1901, p. 83-85, with figures.

Outram Bangs and Thos. S. Bradlee.—The Auk, for July, 1901, pp. 249-57.

A. K. Fisher.—Bird Lore, Oct., 1901, p. 178.

A. E. Verrill.—Note on the Nomenclature of Bermuda Birds, Amer. Jour. Science, p. 470, 1901; Trans. Conn. Acad., xi, p. 58, 1901.

35.—*Introduction of Reptiles and Amphibians.*

a.—American Blue-tailed Lizard. (*Anolis principalis* L.)

FIGURE 68.

An account of the discovery of a single specimen of this species in the Bermuda collection of the late G. Brown Goode (1876) has already been given by me in another place.*

* Trans. Conn. Acad., vol. xi, p. 57, 1901.

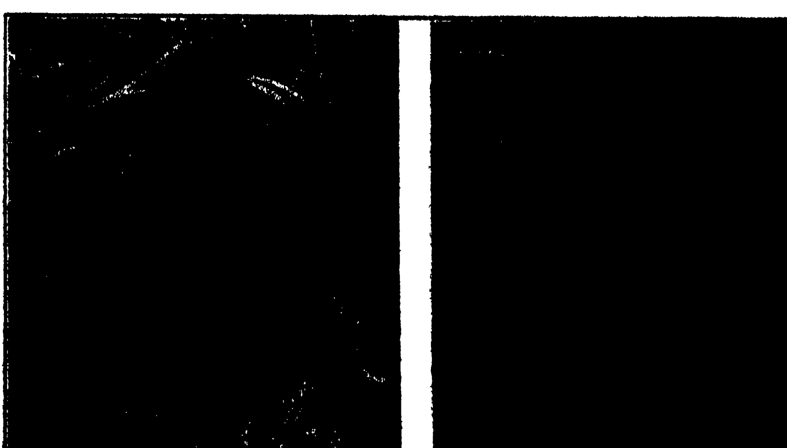
It was probably either an accidental introduction or else an escaped pet lizard, no other specimen having been seen. But it would probably be easy to introduce the species. It is common in the West Indies and the southern United States.

Figure 63 —Blue-tailed Lizard (*Anolis principalis*), Bermuda specimen, enlarged Photog. from nature by A. H Verrill.

b.—Great Surinam Toad; Agua Toad. (*Bufo agua* Daud.)

FIGURES 64, 65.

This species, which is considered the largest existing toad, is now common in many parts of the Main Island, especially in the marshes.* It was also seen by us on Castle Island, in an old drain,



Figures 64 and 65.—Great Surinam Toad; Agua Toad (*Bufo agua* Daud.) Photog. from life by A. H. Verrill, 1901.

* A good account of this toad was published in Science, xiii, p. 342, March, 1901, by F. C. Waite, Univ of New York.

in 1898. During the breeding season, in early spring, they often get into water tanks, and being unable to escape, die there and spoil the water. The eggs are also laid in the brackish water of the marshes and will develop in such places, though the species seems to prefer fresh water for its eggs, when available. A large female will lay an enormous number of eggs.

This toad has long ago been introduced into many of the West Indies from South America. It has a wide range, from southern Mexico to Brazil and Argentine. In Barbadoes and Jamaica it is valued because of its habit of catching field-rats and insects. In the stomachs of those that I dissected were only wings and other fragments of cockroaches and ground beetles, with some fragments of dry twigs probably swallowed accidentally. Young ones, about half an inch in length, are often abundant in Bermuda, after showers in July.

It was introduced into Bermuda directly from British Guiana, by Capt. Nathaniel Vesey, about 1875. About two dozen were taken to Hamilton and mostly liberated in Devonshire Parish, from whence they have dispersed themselves considerably. But it is possible that they had long before been introduced by others, in small numbers, for otherwise it seems strange that they should have reached Castle Island, which has been long uninhabited. Possibly the ancestors of those seen there and in some other parts may have been introduced from the West Indies by soldiers, as early as 1812, but it was not noticed by Hurdis, 1847–55.

This toad is believed in South America and the West Indies, as well as in Bermuda, to have a very poisonous secretion from its parotid and dorsal glands. It is said that dogs that mouth them invariably die within a few hours. The secretion of the glands, when injected into the circulation of dogs, birds, and other animals, causes convulsions and death, even when in small doses. Mr. A. H. Verrill, of my party, on one occasion saw the venom ejected as a fine spray, from the parotid glands of a large toad, when it was much irritated.

36.—*Introduction of Land Snails and Slugs.*

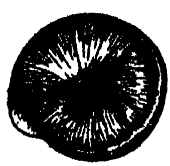
a.—Native Species.

As compared with the smaller West Indian Islands, the Pulmonata are here very few. The total number recorded from the Bermudas is but 42, including 15 semiaquatic species found only on the sea

shores or around the borders of brackish swamps, belonging to *Alexia; Pedipes*, 2 sp., fig. 66; *Plecotrema; Melampus*, 5 sp.; *Truncatella*, 3 sp.; *Onchidium*. These last were probably introduced by natural means. Of the truly terrestrial species there are 4 slugs and 23 snails. Among the snails there is a single endemic genus (*Pœcilozonites**), with three living and four fossil species, of which three

67*a*

67*b*



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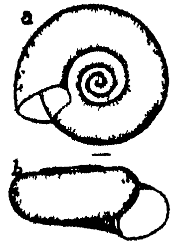

Figures 67*a*, 67*b*.—*Pœcilozonites circumfirmatus;* ×2½. Figures 68, *a*, *b* —*Thysanophora hypolepta ;* ×10. Figure 69.—*Helicina convexa ;* ×2. 67, 69, by A. H. V.; 68, by Pilsbry.

are extinct. (See Part IV.) Two other species of snails are also supposed to be endemic, viz., *Thysanophora hypolepta* Pilsb. (fig. 68), and *Helicina convexa* Pfr. (fig. 69), but these are closely allied to West Indian forms. The large slug (*Veronicella Schivelyæ* Pilsb., fig. 84), known only from Bermuda, in its habits and localized distribution appears like an introduced species, but if so its origin is still unknown.

The following native species of West Indian origin are supposed to have been introduced independently of human agency :

Thysanophora vortex (Pfr.); Greater Antilles; Bahamas; Southern Florida. Figs. 70, *a*, *b*.

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* This genus is the most interesting one. Its largest species (*P. Nelsoni*) is extinct, but it occurs abundantly in the older cave-conglomerates and æolian limestones, sometimes in strata exposed only at low tide, thus showing that it lived on the islands before their partial submergence, and indicating the comparatively great antiquity of the genus. Its nearest allies are now found in the eastern United States. The three living species are *P. Bermudensis ; P. Reinianus ; P. circumfirmatus* (fig. 67*a*, 67*b*). A variety of the first is abundant as a fossil in the later and softer limestones, often retaining very distinct bands of brown color. The fossil variety (*zonata* V., nov.) is rather larger with a thicker and firmer shell, larger umbilicus, and thicker callus than the living form. Both varieties vary considerably in height of spire, size of umbilicus, and color. For two series of comparative figures, see Part IV, Geology.

Polygyra microdonta (Desh.); Bahamas. Fig. 72.

Zonitoides minusculus Bin.; Greater Antilles; whole United States. Fig. 71.

Pupa (*Bifidaria*) *servilis* Gld. = *pellucida* Prime; Cuba; Bahamas. Fig. 74*a*.

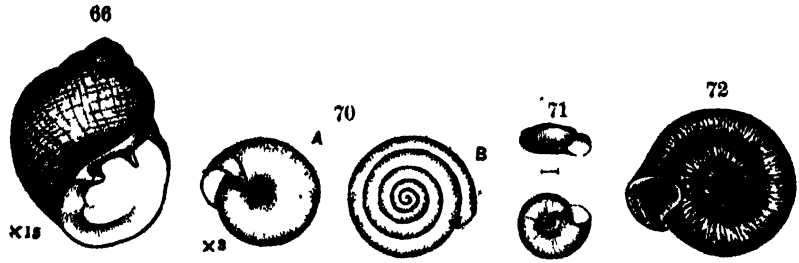

Figure 66.—*Pedipes tridens*; ×15. Figures 70, *a*, *b*.—*Thysanophora vortex*; ×8. Figure 71.—*Zonitoides minusculus*; ×4. Figure 72.—*Polygyra microdonta*; ×8. 66, 70, 72, by A. H. V.; 71, by E. S. Morse.

Pupa (*Bifidaria*) *Jamaicensis* Adams; Jamaica. Fig. 74*b*.

Pupa (*Bifidaria*) *rupicola* Say; Cuba; Florida. Fig. 74*c*.

Pupoides marginatus (Say); Greater Antilles; United States. Fig. 73.

Perhaps some of the other common species, as *Helicella ventricosa* and the *Succinea*, should be added to this list.

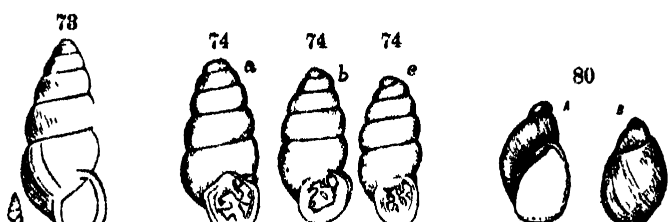

Figure 73.—*Pupoides marginatus*; × 6½. Figure 74*a*.—*Pupa servilis*; × 9. Figure 74*b*.—*Pupa jamaicensis*; × 9. Figure 74*c*.—*Pupa rupicola*; × 9. Figures 80, *a*, *b*.—*Succinea Barbadensis*; × 3.

But much the larger numbers of slugs and snails are believed to have been introduced in rather modern times by means of commerce, and more especially in connection with the introduction of growing plants, for the eggs and young might easily be introduced in large numbers in the earth with potted plants, or in that adherent to the roots of trees and shrubs. The dates of introduction of some of these are pretty accurately known, and in some cases they are quite modern; others are very uncertain.

b.—Introduced Snails.

FIGURES 75, *a, b, c*; 76, *a, b*; 79*e*.

The "Spiral Snail." (*Rumina decollata* (L.).

On account of its great abundance and the damage that it does to the crops, the "spiral snail" is the most important species. This appears to have been accidentally introduced by Governor Lefroy,

Figures 75, *a, b, c*.—Spiral Snail (*Rumina decollata*); × 1¼; *a*, adult, ordinary form; *b*, adult example, still retaining most of the apical whorls; *c*, a young shell with perfect apex. Figures 75, *d, e, f*.—*Polygyra appressa*, showing variations; × 1¼.

with growing plants from Teneriffe, in 1876. A single specimen was found in that year by J. M. Jones, in the garden at Mt. Langton.* A few other specimens were found, from time to time, in and about Hamilton and in Paget Parish from 1877 to 1881, when it was still rare and local; in 1882 it was common in some localities. Soon after this it began to spread rapidly over the Main Island in all directions, but most rapidly along the principal highways. By 1890

* The Yale University Library now owns the copy of the Memorials of Bermuda presented to J. M. Jones by Governor Lefroy. Inserted on the fly leaves is an autograph letter from Lefroy to Jones, dated October 18, 1877, after leaving Bermuda, in which he mentions finding a second specimen of this snail in the garden at Mt. Laugton, in 1877. In this letter he also refers to the "large slugs" (probably *Veronicella Schivelyæ*), as abundant in the garden of Mr. French. The first specimen of *Rumina*, found by Jones in 1876, is recorded in the Essay, No. 8, by Mr. Morris A. M. Frith, who quotes a letter from Mr. Jones in regard to it. But the earliest printed record of the species is by J. T. Bartram, in his List of Bermuda Shells, printed in the Bermuda Almanac for 1878. It is not in his list for 1877.

it had become abundant and injurious over a large part of the Main Island. Its ravages soon attracted the attention of the Board of Agriculture. Finally a prize was offered by them for the best essay on this snail. Five of the resulting essays were published together in pamphlet form.*

At the present time this snail is exceedingly abundant over all of the Main Island and the other islands connected directly with it, being carried about by carts and in various other ways, and with merchandise of many kinds. It is very prolific and has very few natural enemies. It feeds on a great variety of plants, including

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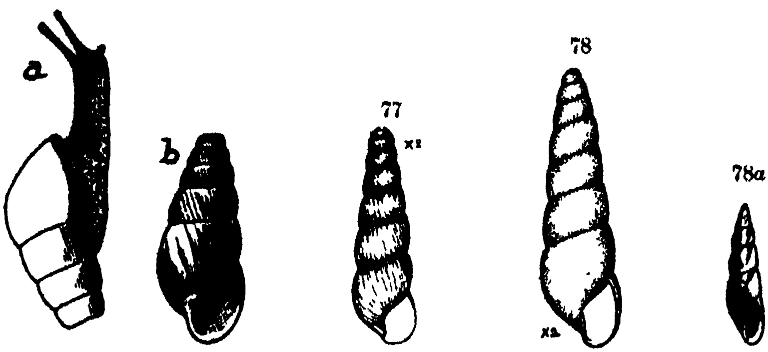


Figure 76.—Spiral Snail (*Rumina decollata*); *a*, animal expanded; *b*, shell; both natural size. Figure 77.—*Subulina octona*; ×2. Figure 78.—*Opeas Swiftianum*; ×2¼. Figure 78*a*.—*Cæcilioides acicula*; after Binney.

nearly all cultivated crops. Hand picking is practised to a large extent and great quantities are destroyed, but the total number seems to be constantly increasing.

The Tropic Bird has learned to eat it at certain times, but whether to any great extent is not known. (See p. 680.) Probably the great

* "Five Essays as furnished to the Board of Agriculture in response to an advertisement offering prizes for the descriptions of and the History of the Spiral Snails, and the most efficacious, expeditious, and economical methods to effect their extermination." Printed by Gregory V. Lee, Queen's Printer, Hamilton, Bermuda. (No date.)

The Essays are by the following authors: 1, by the Rev. W. G. Lane. 2, by Theophilus Roach. 3, by Morris A. M. Frith; appended to this are copies of letters from J. M. Jones and John T. Bartram, giving facts as to the earliest date, 1876, of the introduction of *R. decollata*, as indicated by finding a single specimen. 4, by O. T. Middleton. 5, by Miss Annie Peniston, contains many facts as to the date of introduction and rate of diffusion.

Agua Toad may also eat it. The use of poisons, like lead cyanide, on the leaves of succulent plants of which it is fond, might be useful.

Slender Snails. (*Subulina octona* (Ch.); *Opeas octonoides* (Ad.); *O. Swiftianum* (Pfr.).

FIGURES 77, 78

These three species of West Indian Achatinidæ are usually found, in the daytime, under stones and old logs. They have translucent, whitish, elongated shells, and are sluggish in their habits. The first named, which is the most common, was first recorded by T. Bland, in 1881; the second and third were recorded in 1888, but both are still rare. A fourth and very small species of this group (*Cæcilioides acicula*), from Europe, was recorded by T. Bland in 1861, but has not been observed recently and may have died out. Fig. 78*a*.

The *Ennea bicolor*, a small, widely distributed East Indian species, of which a single example was collected by Heilprin in 1888, and recorded by Pilsbry in 1900, was not found by our parties.

American Toothed Snail. (*Polygyra appressa* (Say).

FIGURES 75, *d*, *e*, *f*

This North American species, which is now very common, at least in Hamilton Parish and Smith Parish, was recorded by Mr. J. T. Bartram and J. M. Jones, in 1876, as found only in a single locality near St. George's. It was first recorded by Temple Prime, in 1853, (Bermuda Almanac) under the name of *Helix Sancta-Georgiensis*, n. sp.

It is nocturnal in its habits and may be found during the day concealed under stones in the borders of gardens and fields, associated with several other species, especially with *Helicina convexa*, *Pœcillozonites Bermudensis*, *P. circumfirmatus*, *Eulota similaris*, *Opeas Swiftianus*, etc. It is common in the middle and southern United States. The Bermuda form is the southern variety.

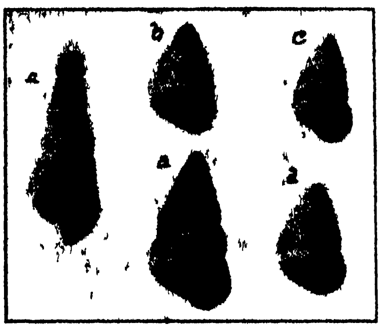
Tree Snails; Bark Snails. (*Helicella ventricosa* (Drap.); *Vallonia pulchella* (Müll.); *Succinea Barbadensis* Guild.)

FIGURES 79, *a*, *b*, *c*, *d*.

The first named of these is the most abundant. It is found in the crevices of the bark or in other sheltered spots both on standing and fallen trees of various kinds, including cedars and cycads, sometimes

in great numbers; the old and young are associated together in clusters. It is often prettily variegated or mottled with dark brown, light brown, and yellowish tints. Owing to its small size it probably does but little damage. It may have been an indigenous species of West Indian origin.

The *Succinea* (figures 80, *a*, *b*, p. 729) occurs in similar situations, though less common, but it is sometimes found on particular trees in large numbers. It was first recorded by Temple Prime in 1853, in the Bermuda Almanac, but it may have been indigenous.



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Figures 79, *a*, *b*, *c*, *d* —*Helicella ventricosa*, × 1¼, *e*, *Rumina decollata*, young, × 1¾. Figures 81, *a*, *b* —*Hyalina lucida*, × 1¼. Phot by A H V

Vallonia pulchella was recorded by J. M. Jones, in 1876. It has not been observed by recent collectors, but this may be because it has not been looked for with sufficient care. It is a native of Europe and is also common in North America. It prefers the crevices of the rough bark near the base of hardwood trees. It may easily be distinguished from the other very small species by the reflexed lip.

European Snail. (*Hyalina lucida* (Drap.).

FIGURES 81, *a*, *b*.

The fresh shells of this species were found in large numbers by A. H. Verrill, in March, 1901, in a garden at Hamilton* but none were living. The last whorl of many of the shells was distorted and rough, as if the conditions had been unfavorable for some time before death. Perhaps the weather was too dry.

It is doubtful, therefore, whether it has succeeded in establishing itself permanently in the islands. It is a native of southern Europe. (See also this vol., pp. 35, 62, 1901.)

* The garden of Mr. Bell, at "Llandwithe"

The European Garden Snail (*Helix nemoralis*) was reported by W. G. Lane (Essay on Spiral Snails, No. 1), but has not been observed by others. It was, perhaps, an erroneous identification of *P. Bermudensis.*

White Snail; Clear Snail. (*Eulota similaris* (Fer.).

FIGURES 82, *a*, *b*, *c*.

This shell, which is translucent and pale yellowish in color, though of Old World origin, is now widely distributed in the warmer parts of both hemispheres. It was probably introduced into Bermuda

Figures 82, *a*, *b*, *c*.—White Snail (*Eulota similaris*); different views; × 1⅓.

from the West Indies, where it is common in Barbadoes, Cuba, etc. It was first recorded from the Bermudas by Mr. T. H. Aldrich, in 1889. We found it common in 1898.

* *c.—Slugs.*

European Garden Slugs. (*Limax flavus* L.; *Agriolimax lævis* (Müll.); *Amalia gagates* (Drap.).

FIGURE 83.

These European species are sufficiently common, but were not found in such numbers as to indicate that they are notably injurious. They were rarely seen in the daytime, except under stones and logs,

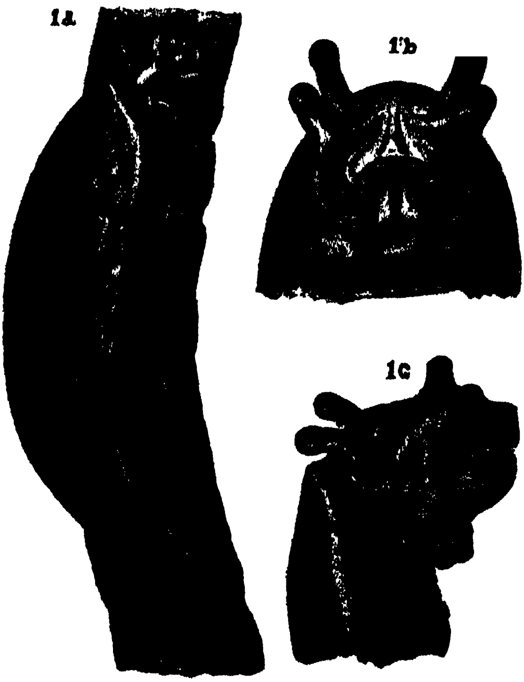
Figure 83.—Garden Slug (*Limax flavus*); natural size.

but were taken at night by lantern light. Probably the occasional drouths are unfavorable for their great increase. The *L. flavus*, though common, was not recorded until 1900; the others were first recorded from the Challenger Exped. (1873).

Great Slug. (*Veronicella Schivelyæ* Pilsb.)

FIGURES 84, 1*a*, 1*b*, 1*c*.

Although this is not known to occur elsewhere, it seems desirable to mention it here, because it may, perhaps, be found to have been introduced from the West Indies.



Figures 84, 1*a*, 1*b*, 1c.—Great Slug (*Veronicella Schivelyæ*); 1*a*, general view, ½ natural size; 1*b*, under side of head, enlarged; 1*c*, side of head.

It is very nocturnal in its habits; most of those taken were captured at night by the use of a lantern. They were mostly found crawling on limestone fences and on the sides of stone buildings. Some were 12 to 15 inches long and over an inch wide in extension. The color is dark slate-gray, almost black, or more or less mottled. It secretes a large amount of very sticky slime, when irritated, but does not ordinarily leave a trail of slime behind it, when it crawls naturally. It is said to be common in some of the graveyards.

37.—*Introduction of Injurious and Useful Insects.*

a.—Insects mentioned by the Early Writers.

The early writers refer to a few insects that attracted their attention, either because they were particularly injurious or because of

some other notable habits. Among those that they particularly mentioned was a large *Cicada*,* which had a peculiar musical note, sounding to them like the whirring of a spinning-wheel, hence the name "Good Housewife" was given to it, according to Butler. Although it resembles the common North American species (*C. tibicen*), to which it has been referred by authors, its musical note is quite distinct. It lives in the cedars, and at present is usually called "Scissors Grinder," from its note.

A grasshopper is also mentioned as common. This was probably the common green *Conocephalus dissimilis* Serv. (fig. 191). Cockroaches, ants, flies, caterpillars, grubs, and beetles, were mentioned, but they cannot be identified with certainty.

The Corn Weevil (fig. 152), which soon became very injurious to their stored corn, was doubtless introduced from Europe by the earliest settlers.

* *Cicada Bermudiana*, sp. nov. Plate lxxxiii, Figures 1, 2. In size and form similar to *C. tibicen*. Body and head mostly black above; dark yellowish brown and smoky brown beneath, with a pale bluish-gray bloom on the thorax; abdomen nearly black posteriorly. Thorax strongly sculptured above; lateral margins of thorax, in front of wings, yellowish, with a black spot on the edge, on middle of anterior part, a ⊥-shaped or anchor-shaped mark of dull yellowish, metathorax marked with a raised X shaped figure, the central part forming a strong, short, transverse ridge, with a deep pit before and behind it; anterior arms of X are incurved and connect with a slightly H-shaped yellow figure, its anterior end enclosing a black, slightly bilobed area, the W-shaped yellow figure much less distinct than in *C. tibicen*. Legs and operculum of musical organ yellowish brown; proboscis paler, blackish at tip, reaching to between the hind legs. Nervures of wings orange-brown, or dark brown, the color conspicuous on the front margin, blackish near base.

Sexes scarcely differ in color; size varies considerably.

	Length	Alar expanse.	Breadth of head.
Largest male........	33^{mm}	90^{mm}	13^{mm}
Smallest male.......	31	80	12
Female.............	29	82	12.5

Described from specimens collected by T. G. Gosling in summer and preserved for a short time in formalin.

This is much darker than *C. tibicen* (pl. lxxxiii, fig. 3) and the yellow markings on the thorax are much less distinct and somewhat different in form. The W-shaped or M-shaped mark is differently shaped, smaller, and not so well defined; the anterior margin and nervures of the wings are much more strongly colored. Its musical note is quite different and less musical, sounding much like that made by a dry grindstone, hence its name of "scissors grinder." Its larva is said to feed on the roots of cedar, but this needs confirmation.

A law was passed in Aug., 1620, requiring that turkeys should be kept confined during the time of planting corn, because of the damage that they did by scratching it up, and "untill the said corne shall be found to be half legge high above ground." But in August, 1623, this act was repealed because it was found that the cut-worms and caterpillars were increasing very rapidly and devastating the corn. But it is now impossible to identify the species referred to.

Governor Butler's account, 1619, of the insects is as follows:

"The moscitoes [*Culex*] and flies [House-fly ?] also are somewhat over busie, with a certain Indian bugge called, by a Spanish appellation, a caca-roche,* the which, creepeinge into chestes and boxes, eate and defile with their dung (and thence their Spanish name) all they meet with; as doe likewise the little aunt [house ant], which are in the summer time in infinite numbers; wormes [grubs or cut worms] in the earth and mould also, ther are but too many (but of them we shall saye somewhat more by and by), as likewise the grass-hopper,† and a certaine sommer-singinge great flie, [*Cicada Bermudiana*] the sure token of the established springe (and in that respect as the English nightingale and cukoe), whose loud note very much resemblinge the whirle of a spindle, hath caused herselfe thereby to be called the good-huswife."

b.—Modes of Introduction.

The Rice Weevil (fig. 153), Bean Weevil, Larder Beetle (fig. 171), Meal Beetles, and various other household insects, such as the Clothes Moths (figs. 146, 147), Fleas, Bedbug, House-fly, Meat-flies, etc., were doubtless introduced from England by the early settlers, as well as the parasites of domestic animals and poultry.‡ But other more tropical species, such as the Jigger, larger Cockroaches, etc., were brought from the West Indies.

Insects whose larvæ live in fruit or seeds are easily introduced.

* Cockroaches of several species are now abundant. The most common are *Periplaneta Americana*, *P. Australasiæ* Brunn., and *Panchlora Maderæ*. Probably one or more of these may have been indigenous.

† Probably the green *Conocephalus dissimilis*. Fig. 191.

‡ The hens, especially when sitting, and their nests, are badly and injuriously infested with a small, active parasitic insect called "Merrywig" or "Merrywing." I did not see specimens myself, but heard complaints of their abundance.

Wood-boring insects and those inhabiting bark may readily have been introduced with lumber and wood. Various insects, either as eggs, larvæ, or imagos, can be transported in cargoes of hay, grain, and other merchandize, or in packing materials, while the larvæ of aquatic insects are often transported in the water-casks or tanks of vessels.*

As soon as growing plants were introduced, the eggs and young of various insects must have been introduced, both in the soil and adhering to the bark and foliage, while the earth about their roots may easily harbor their larvæ and pupæ. Probably the number of native insects was unusually small, owing to the small number of native food-plants, but with increasing introduction of fruit trees and other plants the number rapidly increased, and probably additional species have been introduced nearly every year since the settlement, but some may often have died out later, owing to unfavorable weather or to the birds.

The very small variety of insectivorous birds and reptiles has, however, been unusually favorable for the increase of insects. Another favorable point of greater importance is the fact that the insect-parasites and other natural insect-enemies of injurious species have not been introduced with them, except occasionally and accidentally. Therefore, although the insect fauna is not abundant, certain species, especially of Scale-insects and Plant-lice, have here often proved very destructive to the fruit trees and to other vegetation, as in the case of the Peach, Orange, Lemon, etc., which have been nearly or quite ruined by insects (see pp. 526, 635, 639). Probably numerous species of American Lady-bugs, Syrphus-flies, and Lace-wings could easily be introduced, which would help to destroy the scale-insects and plant-lice. Perhaps ninety per cent. of all the insects on the islands have been introduced by man, since the settlement.

The following list must be regarded as very incomplete. Doubtless many more remain to be collected.

The insect fauna of Bermuda, as now known, is remarkable for the rarity or total absence of many groups common in most coun-

* Miss Victoria Hayward informs me that Mr. Bartram formerly had in his collection a tree-frog taken alive from a water-cask in Bermuda, and a turtle from a bale of hay.

Certain insects are in the habit of hiding away among merchandize, furniture, draperies, etc., on board of vessels. This is notably the case with many spiders, cockroaches, certain mosquitoes, flies, etc., and probably many have been introduced in that way, by vessels.

tries.* Among Hymenoptera, bumble-bees, saw-flies, and many other families seem to be wanting. In Lepidoptera, the fritillary butterflies, theclas, lycænas, skippers, sesias, and various other families have not been reported; bombycid moths are very rare. Mantispids have not been recorded. Among Coleoptera, not half the common families are yet known. Neither ephemerids, stone-flies, nor white-ants are known,† and caddis-flies are very rare. Of Hemiptera, very few families are reported. Among Orthoptera, the phasmids and mantids are each represented only by a single rare species, and the grasshoppers and crickets by very few. The great order, Diptera, has been much neglected by collectors, and very few of the numerous species have been studied.

* During both my visits, 1898 and 1901, collections of insects were made by me and my parties, and notes on many of them were made, but as our time was mainly devoted to the marine zoölogy and geology, no special efforts could be made to make large collections of insects. As the building which we used as a laboratory in 1901 was used in part for storage of grain, meal, vegetables, etc., many domestic insects were naturally observed; others were taken around the lamps at night. Many were found under stones, while looking for land shells, etc. But no collecting was done with insect nets, nor by beating the bushes, grass, etc. If this could have been done the number of species would have been much larger. Moreover, our collections were chiefly made in March, April, and May, before most of the insects had emerged. Unfortunately, the specialists to whom part of our undetermined species were sent have not been able to report upon them in season for this paper, so that a considerable number that we obtained cannot be included. Mr. Samuel Henshaw has given me the names of a few Orthoptera and Coleoptera; to Mr. H. G. Dyar, I am indebted for the determination of several moths, and many useful notes on their synonymy, and Mr. Nathan Banks has kindly determined some of the Scale-insects, etc. Mr. O. Heidemann has determined several Hemiptera, and D. W. Coquillett a number of Diptera. Other members of the entomological staff of the U. S. Dept. of Agriculture have also determined certain species, as noted in each case.

Mr. T. G. Gosling, of Hamilton, sent me, in 1901, a small but valuable collection of the summer insects. During the past summer Miss Victoria Hayward has sent by mail several small lots, which contained some interesting additions to the fauna, as will be noticed in the following list. She also sent me some notes on insects made in former years from which I have quoted several observations. Recently Mr. Geo. A. Bishop, superintendent of the Public Garden, has sent me some valuable notes on the occurrence of a number of insects injurious to vegetation, especially Scale-insects. These I have inserted, with credit to him in each case. Mr. Louis Mowbray also sent, Oct. 31st, a small but interesting lot, adding a number of species to the fauna.

† After the above had been put in type, a small, winged White Ant was sent to me by mail by Miss V. Hayward. (See pl. xcix, fig. 18.)

The native Cedar appears to be very little affected by insects. A pale green geometrid larva was observed spinning down from its branches late in April, but not in large numbers.

The insects of Bermuda are still too imperfectly known to warrant a tabular statement of their origin. About 225 species are reported in this article, but many are not yet determined specifically. The Lepidoptera and Coleoptera each include about 50 species. Of those that are accurately known, more than 90 per cent. belong also to the fauna of the United States, either as natives or introduced; a few are European; perhaps a dozen are peculiarly West Indian; only two are confined to Bermuda, so far as known. But a large number of those that belong also to the fauna of the United States are nearly cosmopolitan in warm countries, accompanying man and mostly feeding on his property. Such are many of the flies, cockroaches, scale-insects, clothes-moths, grain-moths, grain-weevils, flour-beetles, etc. Many of these are doubtless of Asiatic or European origin, but have been so widely disseminated by man in early times that it is now useless to try to trace their origin. The relatively small number of species hitherto obtained is very remarkable, and is good evidence of the very meager insect fauna, though many species must still remain to be discovered.

c.—Diptera. (Flies, Mosquitoes, etc.)

Several species of domestic flies are abundant in summer, but they were probably all introduced by the early settlers. Among those noticed were the Flesh-flies (*Sarcophaga carnaria*, fig. 85, and *S. rabida*); House-fly (*Musca domestica*, fig. 86); *Musca basilaris;* Blue-bottle (*Lucilia cæsar*, fig. 87); *Lucilia latifrons; Lucilia sericata* Meig. (t. D. W. Coquillett); Blow-fly (*Calliphora vomitoria*, fig. 88); Stable-fly (*Stomoxys calcitrans* fig. 89), common.

Recent investigations have demonstrated the importance of those flies which either breed in, or feed upon, dead animals or human excrement as carriers of the bacterial germs of contagious diseases, like typhoid fever, cholera, etc., especially in localities where infected material is left exposed to the air, as about army camps, and in country localities generally. No doubt they can also convey the disease germs of small pox, scarlatina, tuberculosis, bubonic plague, etc., if they have access to the bodies or infected dejecta of persons suffering from those diseases. Many of the contagious diseases of domestic animals are also diffused by the same means.

The common House-fly, owing to its abundance and familiarity, is one of the most dangerous species. Although it breeds chiefly in horse manure, it will also breed freely in human excrement, where exposed.* The Flesh-flies and Blow-flies feed as larvæ on carrion or flesh of any kind, bones, etc., but the adult flies alight on, and doubtless feed upon, human excreta, as well as upon cooked foods, fruit, etc. The Stable-fly breeds both in horse manure and human excreta.

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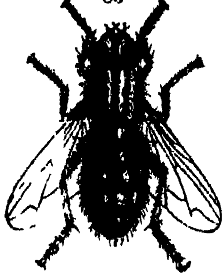

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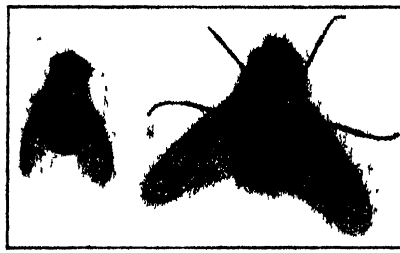

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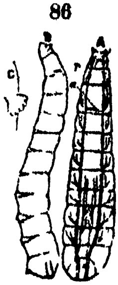

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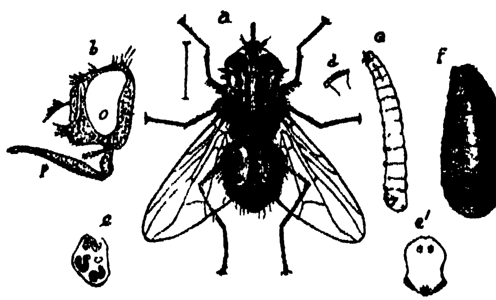

Figure 85.—Flesh-fly (*Sarcophaga carnaria*); enlarged. Figure 86, *a*, *b*.—House-fly; young larvæ much enlarged; after Packard. Figure 87.—Blue-bottle (*Lucilia cæsar*); $\times 1\frac{2}{3}$. Figure 88.—Blow-fly (*Calliphora vomitoria*); $\times 1\frac{2}{3}$; phot. A. H. V. Figure 89.—Stable-fly (*Stomoxys calcitrans*); *a*, fly; $\times 8$; *b*, its head, *o*, eye, *p*, proboscis; *c*, larva, nat. size; *c'*, its head; *f*, pupa; enlarged; after Howard.

The adult fly, which closely resembles the House-fly, bites severely both men and horses, and is often seen in our houses and on food. Many other common flies have similar habits.

Flies of all kinds should, therefore, be carefully excluded from the rooms of patients suffering from any contagious disease, and all infected material should be so disposed of that flies cannot have access to it. The disease germs or bacteria adhering to their feet

*According to Howard 1200 flies may develop in one pound of manure in 10 days.

can easily be carried to human food, to water, food receptacles, etc., or directly to the skin or to wounds. As they often fly long distances in a few minutes, the danger is not merely local. A House-fly, carrying contagion on its feet, may fly in a few minutes from the worst tenement districts of any city to the largest hotels or most elegant houses of the wealthy, and entering their kitchens can deposit the contagion on the costliest food or dishes, if exposed.

Probably this method of spreading contagious diseases, usually ignored, explains in part at least the fact that health-resorts, far from cities, often soon become the reverse of healthy, owing to the diffusion of disease germs by flies, etc.

The abundance of these flies in Bermuda, in summer, will be a source of danger in case of epidemics of any contagious diseases, or even with sporadic cases, for many of the dwelling houses do not have suitable sanitary arrangements for disposing of offal, or for preventing the access of flies. In winter and spring, when visitors mostly go there, these flies are fortunately not very numerous. Most of the larger hotels and boarding houses are now provided with good sanitary arrangements, but to exclude all flies is very difficult in summer, as in other warm countries.*

Onion-fly; Onion-maggot. (*Phorbia ceparum*=*Anthomyia ceparum.*) Figure 90.

We were told that this species occurs, but obtained no specimens of it. The larvæ burrow in the bulbs of young onions.

Anthomyia lepida was also recorded by Jones, 1876.

Grape-fly; Wine-fly; Vinegar-fly; Pomace-fly. (*Drosophila ampelophila.*) Figure 91.

This small fruit-fly is very abundant wherever there is decaying fruit or fermenting fruit juices; it is often associated with other related species, not yet determined. It is also attracted to the dilute alcohol used in preserving specimens. The body is light orange-brown; abdomen with lighter yellowish bands.

Cheese-maggot; Cheese-skipper; Dairy fly. (*Piophila casei.*)

This small, widely diffused fly is also found in Bermuda. Probably it was introduced in cheese or bacon from Europe or America. It is about half as large as a House-fly, with a glossy black body.

* A very liberal and frequent use of kerosene and of chloride of lime on all decaying or infected matter is very useful against flies and their larvæ. For further details, see L. O Howard, Farmer's Bulletin, No. 155, U. S. Dept. Agric., 1902; and Year Book, U S. Dept. Agriculture, for 1901, pp. 177–192

Peach-fly; Peach-maggot. (*Ceratitis capitata* Wied., as *Trypeta.*) Figure 92.

This small fly, whose larva lives in the flesh of the peach, orange, and other fruit, is very destructive. Its ravages have caused the cultivation of the peach, formerly abundant, to be almost entirely abandoned.

This peach-pest was first recorded from Bermuda by Messrs. C. V. Riley and L. O. Howard* from specimens sent to them by C. W. McCallan of St. George's, with an account of its ravages. The article cited gives a pretty full historical account of the insect and excellent figures of the fly and its larva. In the same volume, p. 120, they print another letter from Mr. McCallan, dated Aug. 6, 1890,

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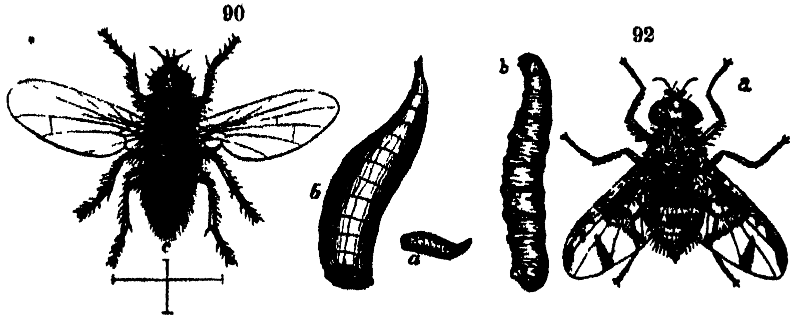

Figure 90.—Onion-fly; *a*, larva, nat. size; *b*, the same, enlarged; *c*, imago, enlarged 8 times; after Packard. Figure 92.—Peach-fly (*Ceratitis capitata*); *a*, imago; *b*, larva, both ×3; after Riley. From Webster's International Dictionary.

giving farther details of its habits. According to him, it was not then known to injure oranges and other citrus fruits in Bermuda, though it does so in other countries, but it was very destructive to the peaches, the larvæ boring in the pulp in large numbers and causing the fruit to fall. He says that the same or a similar larva attacked the loquat and Surinam cherry in the same way. He also mentioned finding the fly on the leaves and fruit of the lime, and on grape vines. He states that they had then been known in Bermuda for about 25 years. In Madeira, the Azores, Cape Verde Islands, Malta, Mauritius, etc., a fly, supposed to be the same species (described by Macleay, 1829, as *C. citriperda*), is very destructive to oranges, causing them to fall when about half grown. It might easily have

* See Riley and Howard. A Peach Pest in Bermuda, Insect Life, iii, p. 5, figs. 1, 2, Aug., 1890; also, vol. iii, p. 120, 1890.

been introduced into Bermuda from Madeira, for oranges and growing plants of various kinds have been brought from there to Bermuda.

Mr. J. B. Heyl, in a communication published in Insect Life (vol. iv, p. 267, 1892), states that this insect was introduced after 1859, having been previously unknown, and that the peaches were before that delicious, but the fly maggots soon ruined all the peaches and also attacked mangoes, loquats, etc.

In a recent letter to the writer, Mr. Geo. A. Bishop, superintendent of the Public Garden, states that not only the peaches, but also oranges, figs, avocado pears, sapodillas, anonas, peppers, loquats, Surinam cherries, etc., are attacked by the pest, many of them being so filled with the maggots as to be worthless.

The prompt destruction of all infested fruit, as soon as it falls, is the chief remedy now available. It passes the pupa state under the surface of the ground, transforming from larva to adult fly in about two weeks in spring—probably sooner in summer. Doubtless it has several broods and attacks other fruits, after the peaches are gone. The fly is yellowish, with dusky or blackish markings; the male has a pair of spatula-shaped hairs on the front of the head.

91 98

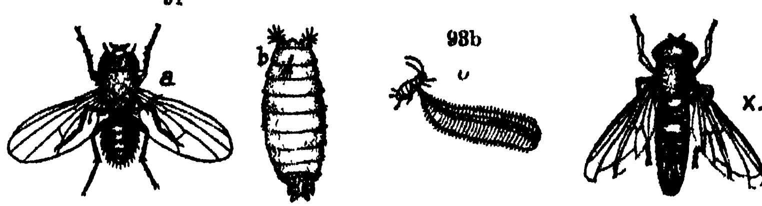

Figure 91.—Grape-fly; *a*, imago, much enlarged; *b*, larva, × about 6 times. Figure 98.—Syrphus-fly (*Allograpta obliqua*); ×2½; after Say. Figure 98*b*.—Larva of a Syrphus-fly eating an aphid, enlarged about 2.

Chætopsis ænea Wied.; Howard, Insect Life, vii, p. 352, fig. 34, *a–c*, 1895; Insect Book, 175, fig. 100. Fyles, Canad. Ent., xxi, p. 236, habits.

This small ortalid fly was recorded by Jones, 1876. In the United States its larva has been observed to injure sugar-cane, corn, oats, wheat, etc., by burrowing in the stalks, many often occurring in one stalk, causing it to wither and die. According to Fyles the larva sometimes destroys other larvæ. The fly is glossy greenish black; wings crossed by two wide bands and a terminal patch of blackish, the bands uniting along the posterior border. Head white; eyes dark brown; legs yellow. Expanse about 10^{mm}.

Syrphus-fly. (*Allograpta obliqua*=*Syrphus obliquus* Say, Ent., i, pl. xi, f. 2.) Fig. 93.

This handsome golden fly was taken in great numbers in April, while hovering around flowers in the gardens. It is common in the middle and southern United States. It was recorded as common by Jones, 1876.

In both sexes the fourth segment of abdomen has an oblique stripe of yellow on each side, and two dorsal stripes of the same. Eyes of male have an upper area of enlarged facets. The larva, which feeds on aphids, is pale green, with faint lighter stripes It is a very beneficial species. See Fig. 93*b*.

A species of Forest-fly or Gad-fly (*Tabanus*) of rather large size and with a large green head, is also common. Uhler, 1888, recorded a different, smaller species, allied to *T. lineola* Fabr. and *T. cincta* Fabr.

Robber-fly. (*Asilus?*) A Robber-fly belonging to *Asilus* or some allied genus is described in Miss Hayward's notes.

Mosquitoes (*Culex*, etc., sev. sp., figs. 94–100) are very abundant, especially in the lowlands and near marshes in summer, but we found them by no means common in March and April. All those collected were species of *Culex*. Whether the Malarial Mosquito (*Anopheles*) occurs here is uncertain, but it has not been recorded nor is malaria endemic. According to Hurdis, one common species of *Culex* has

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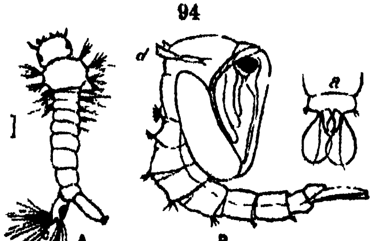

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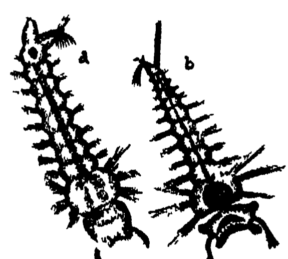

Figure 94.—Mosquito (*Culex*, sp.); A, larva; B, pupa; *a*, caudal appendage; *d*, thoracic spiracles; much enlarged; after Packard. **Figure 95.**—*a*, Larva of Yellow-fever Mosquito (*Stegomyia fasciata*); *b*, larva of *Culex fatigans*; both much enlarged; after Theobald.

the legs conspicuously banded with gray and blackish. Another, abundant in the marshes, is a rather large species, of a nearly uniform brownish color.

Gray Mosquito; Culex fatigans Wied. = *C. pungens* Howard.

FIGURES 95, *b*; 96: 97, 98.

This has been identified by Theobald (Monog. Culicidæ, i, p. 28, fig. 16; ii, p. 151, pl. xxix, figs. 114, 115) as found here, from collections made in July, 1899, by Dr. Eldon Harvey.

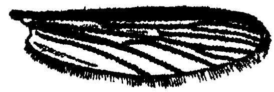

Figure 96.—*Culex fatigans*; wing from a Bermuda specimen, after Theobald

This very objectionable species* belongs to the section of *Culex* in which the proboscis is not banded; legs neither banded nor spotted;

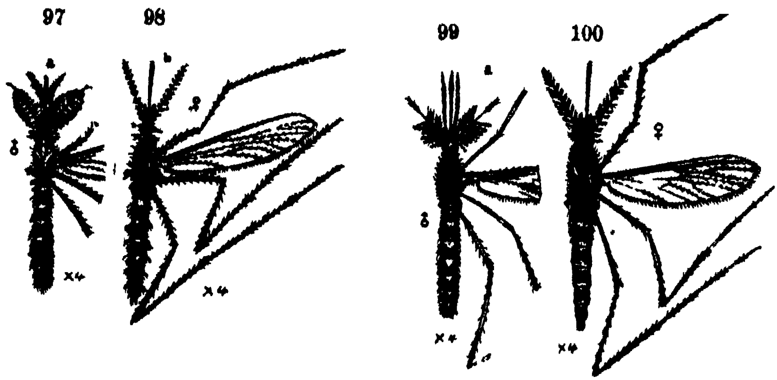

Figure 97.—*Culex fatigans*; male; × 4. Figure 98.—female. Figure 99.—Yellow-fever Mosquito (*Stegomyia fasciata*); male; × 4. Figure 100.—The same; female; × 4 times; after Theobald.

abdomen with light bands at the bases of the segments; thorax with dark lines.

Head and thorax deep brown; thorax with two or three dusky longitudinal lines, and bearing golden brown, narrow, curved scales,

* It is known that in many tropical countries this species conveys the germs of the blood-infecting nematode worm (*Filaria Bancrofti*), which produces the fatal disease called Filariasis of man. Whether this disease has been known in Bermuda I do not know, but it might easily be introduced there by infected sailors or soldiers from other countries by the aid of mosquitoes of this species. A similar disease in dogs, caused by *Filaria immitis*, is transmitted, also, from dog to dog, by species of *Culex*, hence it has been called the *Filaria-bearing Mosquito*. The *C. fatigans* has been found, also, to be one of the species that transmits the blood-parasite of birds, analogous to the malaria-parasite of man, but not the latter.

and about three rows of black bristles; yellowish on sides; abdomen, dark brown or blackish, the segments with narrow curved basal bands of whitish or pale cream-color, and with some whitish lateral spots, upper surface covered with brown or blackish scales; venter whitish. Legs mostly blackish, not banded; coxæ usually ochraceous; femora dark above, gray below, with yellow scales at tip; tibiæ deep brown, ochraceous at tip, bristles brown. This widely distributed mosquito seems to be the most abundant species here.

In the United States from New York to Gulf of Mexico; West Indies; South America; and in nearly all tropical countries.

Yellow-fever Mosquito; Tiger Mosquito. (*Stegomyia fasciata* (Fabr.) Theobald.) Figures 95, *a*; 99; 100.

Probably the yellow-fever mosquito* (*Stegomyia fasciata* (Fab.), figs. 99, 100, had been introduced here from the West Indies, before the first epidemic of that disease (see p. 511), if not on many pre-

* For much information regarding this subject, see the following pamphlet: *Results obtained in Havana from the destruction of the Stegomyia fasciata infected by Yellow Fever; II. The Propagation of Yellow Fever;* by Major W. A. Gargas, Medical Corps, U. S. Army. Sanitary Dep., Havana, Ser. 4, 1902.—These papers are of great interest and importance as demonstrating that yellow fever in Havana is transmitted by this particular mosquito, and in no other way. The disease was fully controlled simply by destroying these mosquitoes in various ways, and preventing them from gaining access to fever patients by the liberal use of screens. By these means and without special disinfection of rooms or clothing, the fever was reduced to a minimum after March, 1901, when this method was commenced. No cases whatever occurred during the four months, from October to January inclusive, which has not happened before in 150 years or more. The average number of deaths from yellow fever from April 1st to December 1st, since 1889, had been 410.54, but by the anti-mosquito methods it was reduced to 5, in 1901; yet in 1900, with the most careful and elaborate methods of ordinary disinfection, very little impression was made on the yellow fever, for there were 1244 cases and 310 deaths in 1900, but in 1901 there were only 18 deaths, 12 of which occurred in January and February, before the destruction of the mosquitoes was commenced. Yet the conditions were in other respects very favorable for a bad epidemic in 1901, for about 40,000 non-immune emigrants had arrived,—a larger number than ever before. In view of such results there seems to be no doubt whatever that the true source of the yellow fever infection has been demonstrated and also that the disease can be easily and surely controlled in all cases, if suitable care be used to destroy this pernicious mosquito. Moreover, the same efforts will simultaneously eradicate the malarial mosquito and other species, as well as the Horse-flies and Forest-flies (*Tabanus*), most of which have aquatic larvæ. For further details see L. O. Howard, Mosquitoes, How they Live, etc. 1901; Insect Book, p. 98; and Geo. M. Giles, Handbook of Gnats and Mosquitoes, London, 1902.

vious occasions, but if so it may, perhaps, have died out in some years during the cool winter months, for it is a tropical species. At least the mature winged insects probably all, or nearly all, die during winter, while the larvæ may live through the winter in the water-tanks to give rise to a new brood in summer. This will account for the cessation of yellow fever here in winter, as in the southern United States, while it may prevail through the whole year in more tropical countries. It is largely a nocturnal species and particularly fond of concealing itself among furniture, draperies, etc., but it will also bite viciously in the daytime.

It is recorded by Theobald (Monog. Culicidæ, i, p 288, 293, pl. xiii, figs. 49, 50), as having been collected here in July, 1899, by Dr Eldon Harvey. It is found in nearly all tropical countries, especially near the coast. Its range is exactly coincident with the distribution of yellow fever. Its habit of concealing itself in close rooms and in the cabins of vessels enables it to migrate to all warm countries.*

The open water-cisterns are ideal places for the breeding of these mosquitoes. In the brackish marshes the abundant minnows, gold-fishes, eels, and dragon-fly larvæ tend to reduce their numbers.

Crane-flies or *Tipulidæ*, which are not numerous, are yet represented by several species, all undetermined except *Dicranomyia distans* Osten Sacken,† originally described from Florida.

J. M. Jones recorded in 1876 the following additional Diptera, not observed by us: *Trypeta humilis* Loew (Monog. Dipt. N. Amer., i,

Deaths from Yellow Fever in the City of Havana.

Month	1892	1893	* 1894	1895	1896	1897	1898	1899	1900	1901
January ...	15	15	7	15	10	69	7	1	8	7
February ..	10	6	4	4	7	24	1	0	9	5
March	1	4	2	2	3	30	2	1	4	1
April	8	8	4	6	14	71	1	2	0	0
May	7	23	16	10	27	88	4	0	2	0
June	18	69	31	16	46	174	8	1	8	0
July	27	118	77	88	116	168	16	2	30	1
August	87	100	78	120	262	102	16	13	49	2
September .	70	68	76	135	160	56	34	18	52	2
October	54	46	40	102	240	42	26	25	74	0
November .	53	28	28	35	244	26	18	18	54	0
December ..	33	11	29	20	147	8	13	22	20	0
Total ...	357	496	382	558	1282	858	186	103	310	18

* On page 511, note, it is erroneously stated that Mr. Theobald records only *Culex* from Bermuda. When that chapter was written I had overlooked his record of Bermuda as a locality from which *Stegomyia fasciata* had been received and also his determination of *Culex fatigans*.

† Monograph Diptera North America, Part IV, p. 67

p. 81, pl. ii, fig. 17, from Cuba); *Tetanocera pictipes* Loew (op. cit., iii, from Washington, D. C., family Sciomyidæ); and *Dilophus*, sp. (family Bibionidæ).

Mr. Uhler recorded, 1888, an undetermined species of *Odontomyia* (family Stratiomyidæ, "Soldier-flies").

Dr. Fr. Dahl (Plankton Exped., vol i, part 1, p. 109, 1892) recorded the following Diptera:

Eristalis æneus? Fab Williston, Bull. Nat. Mus., No. 31, p. 161, (descr.) = *E. sincerus* Harris. N. America, Europe, Canary Is., Malta, etc. The body is shining dark metallic green; eyes spotted with round dots. *Psilopus chrysoprasinus* Wied. A Brazilian fly of the family Dolichopidæ. *Musca basilaris* Macq. Known also from Cape Verde Is., Ascension I., Jamaica, and Brazil. *Fucellia*, sp. *Lucilia latifrons* Schinz. European. *Sarcophagula*, sp. *Limosina*, sp. On dead sea-weed on the shore.

Mr. D. W. Coquillett has determined in our collection, *Scatopse atrata* Say; *Orthocladius*, sp.; *Phora*, sp, and *Psilopus chrysoprasus* Walk., iii, p. 646;* not enumerated above.

d.—Aphaniptera. (Fleas, etc.)

The Human Flea (*Pulex irritans*), fig. 101; and the Cat and Dog Flea (*Serraticeps canis* or *Pulex canis*), fig. 102, which also attacks

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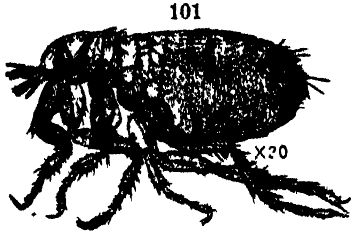

b

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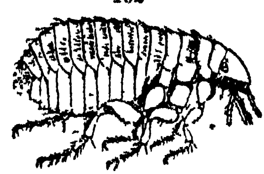


Figure 101.—Human Flea (*Pulex irritans*), much enlarged; *b*, larva of the same, after Claus. Figure 102.—Dog Flea (*Serraticeps canis*), much enlarged. 101, 102, from Webster's International Dictionary.

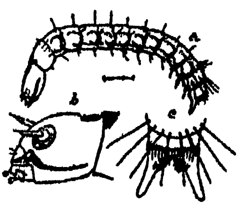
man, are both very common, as in most warm countries, and were doubtless introduced in early times.

The *Jigger* or *Chigoe* (*Sarcopsylla penetrans*=*Pulex penetrans*), fig. 104, which is common in the West Indies and tropical America,

* This brilliant fly has the head bright sapphire-blue, with brown eyes; thorax and abdomen bright emerald-green, the latter with narrow black bands at the sutures; legs black; wings slightly dusky, length, 5mm. West Indies, Walker

appears to be now uncommon in Bermuda, but J. M. Jones (1876) recorded it as common; Hurdis also mentioned it as found here in his time. It chiefly attacks the feet of those colored natives who habitually go barefooted.

103



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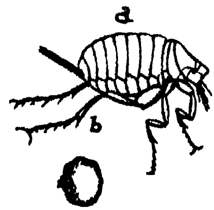

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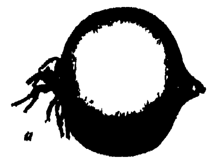

Figure 103.—Larva of Dog Flea, much enlarged; *b*, head, in profile; *c*, caudal appendages; after Chittenden. Figure 104.—Chigoe (*Sarcopsylla penetrans*); *a*, female, much enlarged; *b*, female filled with eggs, natural size; after Packard. Figure 105.—Gravid female of another species of *Sarcopsylla* (not Bermudian); much enlarged.

The Hen-flea (*Sarcopsylla gallinacea* Westw.) probably also occurs here, though we could obtain no specimens. It has been found to infest poultry in Florida, Ceylon, Asia, etc. (See Packard, Insect Life, v, p. 23, figs., 1894.)

e.—Hymenoptera. (Bees, Wasps, etc.)

The Honey Bee (*Apis mellifica*) was undoubtedly introduced by some of the early settlers, though I have found no record of the date. Wax and honey were mentioned as articles exported in 1679. In modern times considerable numbers of bees have been kept by some of the farmers, but their increase is much interfered with by the bee-moth, cockroaches, and ants.

Yellow Wasp. (*? Vespa vulgaris.*) Recorded by Jones, but not seen by our parties.

Hornets and *Wasps.* (*Polistes Canadensis*, *P. perplexus*, and *P. pallipes.*) Figures 106, 107.

This genus is very common in summer. Its nests, consisting only of a sheet of cells, four or five inches across, without paper covering, were found attached to the leaf-stalks of young palmettos, etc. Apparently there are three or more species.

Polistes perplexus Cresson, Trans. Amer. Ent. Soc., iv, p. 245, 1872.

This wasp, originally described from Texas, was recorded by W. F. Kirby as taken at Bermuda by the Challenger Exped., in April and June. (Ann. & Mag. Nat. Hist., xiii, p. 410, 1884.)

The male *Polistes* (fig. 106) was determined by Mr. Ashmead. In alcohol the head is black above, with the front yellowish brown, this color extending as a band below and behind the eyes, but interrupted dorsally. Thorax black above with a rufous brown stripe in front of each wing insertion, meeting anteriorly; two transverse dorsal spots of the same on the middle, and a pair of yellow stripes

106

107

Figure 106.—Bermuda Wasp (*Polistes perplexus*), male, ×1⅓. The photograph, made from dried specimen, did not define the black and orange bands of the abdomen, which are less distinct after drying and required retouching. Figure 107.—The same, female, ×1⅓. Phot. by A. H. V.

farther back; abdomen orange-brown, banded with black, each band usually covering the proximal half of a segment and the distal margin of the one in front, on which it often forms a lunate spot; on the second enlarged segment it forms a dorsal triangular black spot, acute distally; legs orange-brown, darker on the femora. Wings orange-brown, or rufous brown, the veins darker. Length, 22^{mm}; abdomen 12^{mm}. Described from specimens taken from alcohol and still moist; when dry the color-markings are less distinct, the black bands on the abdomen being scarcely visible; its surface is covered with short, close, orange-brown hairs, obscuring the dark bands. Midsummer, T. G. Gosling.

Female (dry) smaller than the male described; head rufous brown; a black shield-shaped mark between the eyes and a narrow transverse

black stripe on the occiput. Thorax with a large cordate dorsal spot, the apex turned forward, edged with yellow, and including two short rufous stripes; sides in front of and behind the wings rufous brown; two rectangular dorsal spots of the same, behind the black spot, both edged with yellow; posterior part of thorax rufous brown, with a median dorsal black stripe and one of yellow each side of it of same width; pedicel with an angular yellow spot on each side. Abdomen rufous brown, each segment narrowly edged distally with brownish yellow; the first enlarged segment with a wider light yellow edge, and with some indistinct blackish spots anteriorly; next segment with a triangular black dorsal spot, the point turned backward; middle segments with indistinct blackish patches; wings smoky brown or blackish; legs light yellowish brown; the femora rufous brown distally; antennæ black. Length, 19^{mm}; expanse, 32^{mm}. August, Miss Hayward. (Fig. 107.)

Geddes records also *P. pallipes*, a smaller North American species.

A burrowing wasp or sand-wasp of the genus *Halictus* was recorded by Dr. Fr. Dahl. (Plankton Exp., i, pt. 1, 108, 1892.)

Jones recorded the genus *Augochlora*.

Wood-wasp. (*Mimesa* Shuck., sp.) A slender-bodied wasp of the family Mimesidæ was also recorded by Dr. Dahl.

Sand-wasp; Digger-wasp. (*Pompilius Philadelphicus* Lep.) This North American species was recorded by Dr. F. Dahl (Plankton Exp., i, part 1, p. 108, 1892.) A species of this genus was also recorded by Jones, 1876, but we did not obtain it.

Mason Wasps; Spider-wasps; Mud-daubers. (*Sceliphron* = *Pelopæus*, etc.)

Yellow-footed Mason-wasp. (*Sceliphron*, or *Pelopæus*, *flavipes*.)

This common North American species was recorded by Jones, 1876.

Large Mason Wasp. (*Sceliphron cementarium* Drury, as *Sphex*, Exot. Ins., i, p. 105, pl. xliv, figs. 6, 8. Smith, Cat. Brit. Mus. Hym., iv, p. 234, as *Pelopæus.* = *P. lunatus* Fab.; Guer., Icon. R. Anim., p. 436, pl. lxx, fig. 5.)

This species is common in the southern United States, West Indies and South America. Closely resembles the next species.

Dr. Fr. Dahl (Plankton Exped., i, pt. 1, p. 108) recorded this species from Bermuda.

Mason-Wasp. (*Sceliphron fasciatum* St. Farg., Hym., iii, p. 315, as *Pelopæus*). Figure 108, *a*, *b*.

Our specimens referred to this species are larger than the last, with a relatively long abdominal pedicel. Length, 27mm; length of pedicel, 6.5mm; of thick part of abdomen, 9.5mm. Head and body all black, except a transversely elliptical spot of dull greenish yellow on the prothorax anteriorly, less distinct spots of the same on the middle and on posterior end of the thorax, and a round lateral spot

Figures 108, *a*, *b*.—Yellow-footed Mud wasp (*Sceliphron fasciatum*), profile and dorsal views, ×1½. Phot by A. H. V.

of dull yellowish on the first enlarged abdominal segment; legs long, black proximally; tibiæ and tarsi light yellow, except for a wide ring of black on the distal part of the posterior tibiæ, and a blackish tint on the two distal tarsal joints; antennæ black, except the yellow basal joint. Wings dark brown. The thorax and head are covered with black hairs. A West Indian species identified by Mr. W. H. Ashmead.

Specimens referred to *Chalybion cæruleum* (L.) (fig. 108*a*) have the body shining blue-black when wet, but with bright metallic or steel-blue and greenish reflections when dry; legs and antennæ black. Wings smoky black. The abdomen is shorter than in the preceding. A common North American species. Summer, T. G. Gosling.

These and perhaps other species, not yet determined, are common in summer, building their nests in out-buildings and under piazza roofs.

Ichneumon-flies. (*Ophion*, etc.)

Several undetermined species of ichneumons were obtained. Among them is a species of *Ophion* very much like our common large species (*O. macrurus*)

Cockroach Ichneumon. (*Evania appendigaster* = *E. lævigata* Olivier; Packard, Guide, p. 194, fig. 173) Figure 109.

This very interesting species was recorded by Jones, 1876. We obtained a specimen in April. It lays its eggs in the egg-cases of a cockroach (usually the American Cockroach), and its larva finds its nourishment and shelter within the case. Thus this useful insect destroys continually great numbers of cockroach eggs. Its body is black; thorax glossy and punctate. It is found also in North Amer-

108a

111a

Figure 108a —Blue Mason-wasp (*C cœruleum*, × about 1¼; phot. by A H V. from a Bermuda specimen Figure 111a —Ant (*Pheidole pusilla*), *a*, minor worker, *b*, major worker or soldier, both much enlarged; t, distal end of tibia, *c*, tibial comb, from drawings of Bermuda specimens by A. H. V.

ica, Hawaiian Is., West Indies, etc. According to Miss Hayward, who has sent specimens, it is common on flowers of honeysuckle in August. October, L. Mowbray. In turn it has an ichneumon parasite (*Entedon Hagenowi*) which destroys its larva, but whether the latter occurs in Bermuda is not known.

Ants. (*Formicariæ.*)

Ants of several undetermined species were collected by us which have not yet been fully studied by a specialist; none of them were winged.

Among the recognized species observed are the small House-ant (fig. 110), and the Garden-ant or Pavement-ant (fig. 111), belonging to the Myrmicidæ. Probably these were early introduced from England. The early writers, however, mention certain ants as

troublesome, so that one or more species may have been native. See Butler's account, 1619, quoted on p. 737.

Mr. Hurdis (Rough Notes, p. 324) mentions two species of injurious ants, viz: the small House-ant (fig. 110), and a much larger one which he supposed to be of West Indian origin. The latter was especially troublesome by destroying food of all kinds. He also stated that they were destructive to rabbits, both old and young.*

He also says that during seven summers previous to 1848 "Bermuda has been infested with ants to a fearful degree," but during that summer their numbers were greatly decreased, by some unknown cause. This must have been distinct from both the small species named above. Probably this is also the one that is said to destroy honey, in the hives.

109

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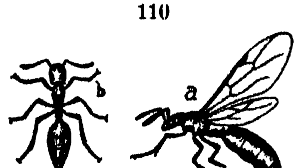

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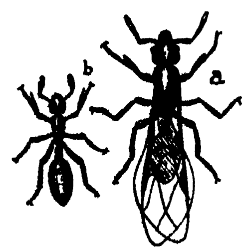

Figure 109.—Ichneumon parasite of Cockroach (*Evania*), male; and *b*, pupa; slightly enlarged; after Packard Figure 110.—House Ant (*Monomorium minutum*); *a*, female; *b*, worker, ×5 Figure 111.—Pavement or Garden Ant (*Tetramorium cæspitum*); *a*, female; ×8; *b*, worker; ×4. Both ants from Webster's International Dictionary; after Marlatt.

European Black Ant. (*Formica nigra* L.) This common European species was recorded by W. F. Kirby as collected in Bermuda by the Challenger Exped. (Annals & Mag. Nat. Hist., xiii, p. 404, 1884).

Dr. Fr. Dahl (Plankton Exped., i, pt. 1, p. 109) records two additional species:

Pheidole pusilla (Heer). Smith, Catal. Brit. Mus. Hym., vi, p. 173, pl. ix, figs. 18–20. A small species related to the agricultural ants. The major workers or soldiers have remarkably large heads and powerful jaws. Specimens of both the major and minor workers of this species, taken at St. Davids I., in October, were sent to me by

* "Hill and dale and even the dwellings of men were equally alive with this insect pest. Dense columns of them might be seen travelling up and down every tree, and great was the havoc they occasioned among young pigeons and poultry, nor did the full-grown domestic rabbit escape their deadly attack, and pigs were sometimes destroyed by them." Rough Notes, p. 324.

Miss V. Hayward. A detached head of the former was also found with its jaws still firmly grasping the leg of a hard-back beetle. Native of Madeira. Figures 111*a*, *a*, *b*. A much larger, chestnut-brown, winged female, 6^{mm} long, of this genus (t. Ashmead) was also sent in November.

Odontomachus Latr. (sp.). A jumping ant of the family Formicidæ, near *O. insulans* of the West Indies.*

f.—Lepidoptera. (Butterflies; Moths.)

Among the most conspicuous of the introduced insects are several species of North American butterflies. Some of these may also have been indigenous, for it is known that the stronger-winged species, like *Anosia plexippus*, are capable of flying to even greater distances. Some of them have come aboard of vessels a thousand miles or more from land.

Moreover, vast flocks of one small, American, sulphur-yellow species (*Eurema lisa*) have been seen to come from over the sea and arrive on the shores of Bermuda, like the migratory birds. Perhaps they may be aided by strong winds in these cases. Some of these remain and breed on the islands, if they find here suitable plants for the food of their larvæ Thus they may often have arrived here before the advent of man, but if there were then no plants suitable for their food they could not have become naturalized.

This must have been the case with the Asclepias Butterfly (*Anosia plexippus*), for the only plants on which its larvæ can feed have been introduced since the settlement, and probably the same is true of most of the others. Thus their naturalization has been indirectly, if not directly, due to man.

During the winter and spring, when most of the entomological collections have hitherto been made, the number of Lepidoptera that are active is small.† A few butterflies, like *Anosia plexippus*, are

* See Guer.-Men , Hist I Cuba, vii, p 317, pl. 18, figs. 7–7d

† While working late at night, nearly every night in April, with the windows open, very few species came to the lights, not more than a dozen of moths altogether. But of these one or two species were very abundant, especially a moth, about 28^{mm} in expanse, mottled with light and dark gray, in varying proportions, some specimens being very dark or blackish gray, while others were much paler or stone-gray; (? *Heterogramma*, sp.). Unfortunately Mr. S. Henshaw, to whom many of my moths were sent for determination, has not been able to report on them in season for this article. But the number of additional species is not large.

active all winter and the same is true of a few moths. In April, the spring brood of some of the moths appears, mainly small pyralids, geometrids, and tineids, with a few noctuids; as the season advances the number of species rapidly increases, and without doubt in summer a large number could be found. In April, several species of *Crambus* or Grass Web-worm moths and other moths were common in grassland, but most of those obtained have not been determined specifically.

Little Sulphur Butterfly. (*Eurema lisa* Hub.; Scudder* = *Terias lisa* of most writers, as in Jones, 1863 and 1876.)

FIGURE 112.

This species, referred to above, is one of the most abundant. Its pale sulphur- or canary-yellow wings are externally bordered with dark brown, and the front wings are tipped with the same, and

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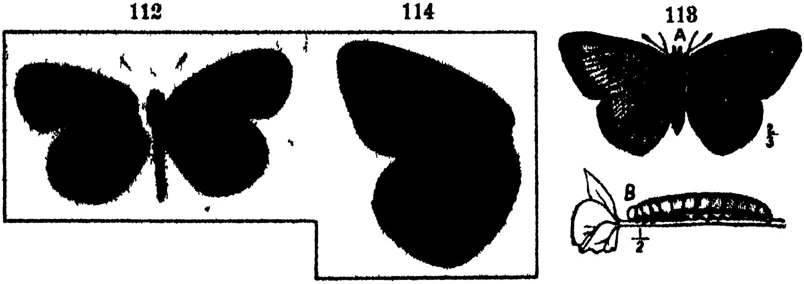


Figure 112.—Little Sulphur (*Eurema lisa*); male; natural size; after Scudder. Figure 113.—Clouded Sulphur (*Eurymus philodice*), A, male imago, wings reversed on right side; ⅓ natural size; B, larva; after Packard. Figure 114.—The same; wings of female; natural size, after Scudder.

edged with reddish. The male has a few reddish specks on under side of hind wings. The expanse of its wings is about 1.25 inches.

Hurdis (Rough Notes, pp. 317–323) mentions a large flock, containing thousands, that arrived, doubtless from over seas, Oct. 10, 1847. J. M. Jones published† in 1875 an account of a vast flock that arrived, Oct. 1, 1874. They were first seen out at sea by fishermen fishing on the reefs. They arrived on the north side of the Main Island, appearing like a vast cloud, which soon divided into

* In naming the butterflies I have followed the nomenclature of Mr. S. H. Scudder's classical work: Butterflies of the E. U. States and Canada.

† Psyche, i, p. 121, 1875; and Entom. Soc. Lond., ix, p. 54, March, 1876.

two parts, going to the East and West. They alighted in grassy places, seemed rather fatigued, but only remained a few days. They were extensively preyed upon by the bluebirds and catbirds.

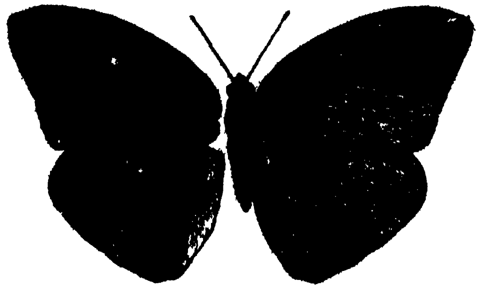


Figure 115.—Cloudless Sulphur (*Callidryas eubule*); female; natural size, wings reversed on left side; after Scudder.

This butterfly seems to be now naturalized on the islands, for it has been taken by nearly all recent collectors in late summer or autumn. Its larva, which is green, feeds mostly on various species of *Cassia*, and therefore is not injurious to man; rarely on clover.

Clouded Sulphur; Common American Sulphur. (*Eurymus philodice* (L.) Hubn.; Scudder = *Colias philodice* of most authors.)

FIGURES 113, 114.

This was first recorded by J. M. Jones in 1876. It was contained in a small collection sent to me by Mr. T. G. Gosling in 1901, so

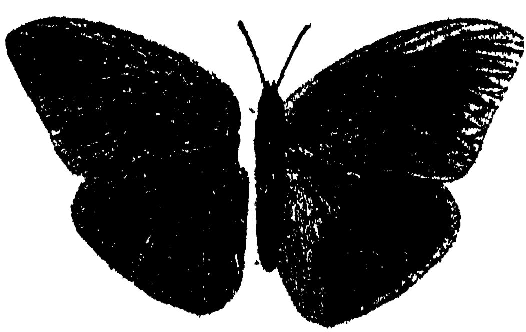


Figure 116.—Cloudless Sulphur (*Callidryas eubule*); male; natural size; wings reversed on left side; after Scudder.

that it is now probably permanently naturalized. Its green larva feeds mostly on clover and allied plants, sometimes on peas and lupines.

Cloudless Sulphur; Citron Butterfly. (*Callidryas eubule* (L.) Bois.-Lec.; Scudder= *Catopsila eubule* Kirby; Holland.)

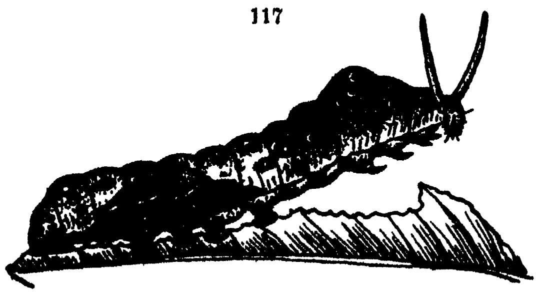
FIGURES 115, 116.

This large, nearly plain yellow butterfly appears to be rather uncommon here. Hurdis mentions seeing a butterfly agreeing well with this. Miss Victoria Hayward has sent me MSS. notes on specimens apparently of the female; "Wings bright sulphur-yellow tinged with greenish; anteriorly edged with purplish black; posterior edge faintly reddish; with red and gold dots at the distal ends of the veins; thorax black with yellow scales; antennæ red; legs nearly white; expanse, 3.5 inches."

The female has larger, brownish marginal spots than the male, and also a small discal spot of reddish brown on the upper side of the fore wings. The male is nearly plain canary or sulphur-yellow.

Common in the southern United States; sometimes flies in great flocks. The larva feeds on various species of *Cassia*.

117



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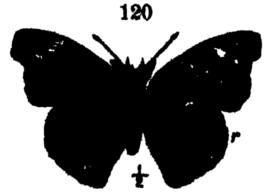


Figure 117.—Orange-dog (*Heraclides cresphontes*); larva; reduced. Figure 120.—Red Admiral; ½ natural size. Both from Webster's International Dictionary; 117 after Saunders; 120 after Harris.

European White Cabbage Butterfly. (*Pieris rapæ* L.)

A white butterfly, apparently of this species, was seen in April, 1898 and 1901. Abundant in Europe; introduced about forty years ago into North America (1860). Its green larva feeds mainly on cabbages and allied cruciferous plants.

Great Black and Yellow Butterfly; Orange-tree Butterfly; Orange-dog; Cresphontes. (*Heraclides* (or *Papilio*) *cresphontes* Cr.)

FIGURE 117. PLATE LXXXI; FIGURES 1, 2, 3, 4, 5.

This fine species was seen by A. H. Verrill, April, 1901. The large larva feeds on the leaves of the orange and lemon trees, and

is called "Orange-dog" in Florida. The butterfly, which is our largest species, is yellow and black, some individuals having much more yellow than the one figured, there being dimorphic broods. Common in the Southern United States, and not rare in southern New England. Its larva feeds also on the prickly ash, hop-tree, rue, fraxinella, and Kentucky coffee-tree.

A species of *Papilio*, resembling *P. troilus* and *P. polyxenes*, was also seen in April, 1901, but not captured.

Painted Lady; Thistle Butterfly. (*Vanessa cardui* (L.) = *Pyrameis cardui* of many authors). Figures 118, 1*a–e*.

First recorded by Hurdis as occurring Sept. 4, 1847, in some numbers, also Sept. 11, 1849, and Aug. to Nov., 1854; and by Jones, 1863. Not uncommon in autumn, but doubtless has two broods. Its larva feeds on thistles, burdock, sunflower, and allied composite

118 119

Figure 118.—Painted Lady (*Vanessa cardui*); 1*a*, *b*, larvæ; *c*, pupa; 1*d*, *e*, imagos. Figure 119.—Red Admiral (*V. atalanta*); 2*d*, *e*, imagos; *a*, *b*, *b'*, larvæ; 2*c*, pupa Both 2/3 natural size; after Berge.

plants; sometimes on mallows and hollyhocks. It is widely distributed in both hemispheres. Easily distinguished from the Red Admiral by lacking the oblique orange-red band across the fore wings; the under side of the fore wings is bright pink or rose-red centrally; the round spots of the hind wings beneath are blue; black above.

Red Admiral; Nettle Butterfly. (*Vanessa atalanta* L.)

FIGURES 119, 2a–e; 120.

Recorded first by Mr. Hurdis as occurring Sept. 4, 1847, and May 14, 1849; also by Jones, in 1863 and 1876. It does not appear to be common, though permanently naturalized.

It is easily distinguished by the obliquely divergent band of bright orange-red across the middle of the fore wings, and on the posterior margin of the hind wings, and a group of white spots near the apex of the fore wings. The ground-color is purplish black above. The larva feeds on the hop-vine and nettles, making a nest of the folded leaves. There are two or more broods, and the late adults often hibernate. October, L. Mowbray.

It is widely diffused in both hemispheres, like the last.

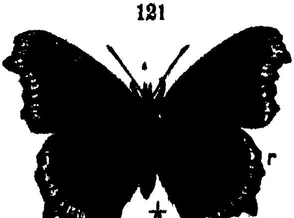
Camberwell Beauty; Mourning-cloak; Elm Butterfly. (*Euvanessa antiopa* Scudder = *Vanessa antiopa* (L.), of most authors)

FIGURES 121, 122, 122a

This large, handsome species, common in North America and Europe, appears occasionally in Bermuda, but it may not yet be

122 122a

121



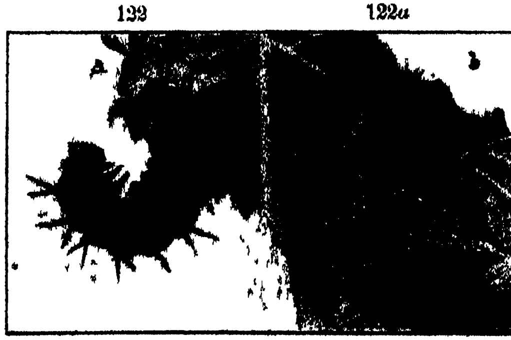


Figure 121.—Mourning Cloak (*Euvanessa antiopa*); *r*, *r*, reverse of wings; ½ natural size. From Webster's International Dictionary; after Harris.
Figure 122.—Mourning Cloak; larva preparing to change to chrysalis
Figure 122a.—The same, just transformed to chrysalis. Both ⅞ natural size. Photographs from life by A. H. Verrill

naturalized there. It may fly direct to Bermuda, but individuals in the pupa state, or hibernating imagos, might easily be introduced by vessels. It was first recorded by Hurdis, as seen Oct. 23, 1847; also Sept. 12, 1854; a single individual in each case. Several specimens

were seen in April, 1901. Its large, purplish black, spinose larvæ feed on the elm and willow, sometimes on poplars; in Bermuda probably on the weeping willow. Easily recognized by its dark maroon-brown wings, bordered by a row of blue spots and a marginal light drab band.

Single specimens of *Vanessa io** (fig. 123) and of *V. polychloros*† are recorded by Jones, 1876, as taken by Canon Tristram in 1848. They are both European species. It is doubtful if they have become fully naturalized here.

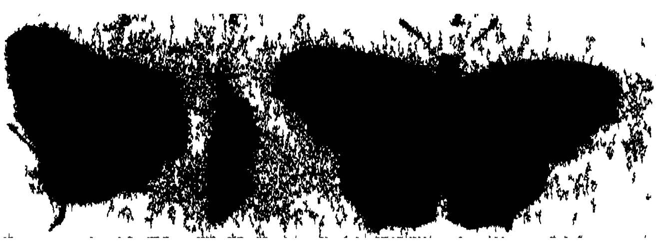


Figure 123.—European Peacock Butterfly (*Vanessa io*); *a*, *b*, imago; *c*, pupa; ⅔ natural size, after Berge

Musk Butterfly; Buck-eye; Lavinia; Peacock Butterfly. (*Junonia cœnia* (Hubn.); Scudder; Holland,‡ etc.). Figure 124.

First recorded by Hurdis as captured May 15, 1849; also Sept. 12, 1854. He stated that it was common throughout the year. J. M. Jones, 1876, says it is "the most common butterfly." It was sent to me by Mr. T. G. Gosling, in 1901. Its larva feeds on *Linaria* (snap-dragon), purple *Gerardia*, and allied scrophulariaceous plants, and sometimes on ground-plantain (*Plantago*). According to Mr.

* *Vanessa io* has the fore wings above reddish brown with four patches of black, separated by yellow, of which two are angular, one semicircular on upper half of ocellated spot, which has lower half brown with yellow dots, and front margin of yellow, five round blue spots in a row; margin dark. Hind wing blackish brown, large ocellated spot with black pupil and blue central spots, border whitish, under side of both wings brownish black. See figure 114.

† *V. polychloros* has the upper side of the wings mostly brownish orange with about six or seven irregular and unequal spots of black on the fore wings; a submarginal band of black, externally margined with yellow, on both pairs; on the hind wings a band of blue between the black and yellow; front edge of fore wings with a submarginal stripe of yellow.

‡ Holland, W. J., Butterfly Book, p. 173, pl. iii, figs. 29, 30, larva; pl. iv, figs. 56, 57, 65–67, pupa, pl. xx, fig. 7, female imago.

Geddes the larvæ, in Bermuda, feed on the common sage-bush (Lantana) He found it very common in spring, but not easy to capture on sunny days. Some individuals remain active all winter.

The ground-color of the wings, above, is dark rufous-brown. The large ocellated spots are light orange, with black center, and paler orange margins, surrounded by a narrow black edge; the two transverse anterior spots near base of fore wings are reddish orange, bordered with black; diagonal bar whitish.

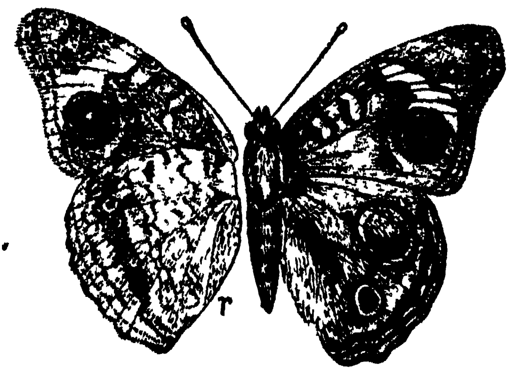


Figure 124 —Buck-eye or Peacock Butterfly (*Junonia cœnia*), *r*, wings reversed, enlarged about 1¼ From Webster's International Dictionary

The larva is usually purplish brown above, yellowish on the sides, with rows of dark branched spines the whole length; two of them on the head.

In the United States it is found from southern New England to the Gulf of Mexico, especially near the coast, but much more commonly southward.

Asclepias Butterfly; Milk-weed Butterfly; Monarch. (***Anosia plexippus*** (L.) Moore; Scudder=***Danais plexippus*** Lat.= ***Danais archippus*** Bois.-Lec., etc.)

PLATE LXXXII; FIGURES 1, 2, 3, 4, 5 PLATE LXXXIII, FIGURE 2

This large orange-brown species, with white spots and dark brown veins, is one of the most common Bermuda butterflies and occurs during all the year. It was first recorded Nov. 17, 1847, by Hurdis, but he states that it was common every year.*

Its larva is black, banded with yellow and white, and has four long black filaments, two anteriorly, on the second thoracic segment,

* Hurdis also records a buff-colored specimen; perhaps a partial albino

and two posteriorly, on the eighth abdominal. It feeds here on the "red head" or false ipecac (*Asclepias curassavica*), a common introduced weed. In other countries it feeds on various other species of *Asclepias* (milk-weeds).

This butterfly is remarkable for its strong wings and long vigorous flights, and also for its migratory habits. In southern New England it assembles in autumn in vast flocks, often of many thousands, which alight to rest on the same tree every night for several weeks early in autumn, and finally they all fly away southward together.

I have observed these flocks on the same tree (or on adjacent trees when disturbed) for over thirty years on Outer Island, in Long Island Sound, not far from New Haven, Conn. They assemble gradually each year, at about the same date, in September, but the time of their southward flight varies somewhat according to the temperature, and may be influenced by the abundance or scarcity of the aster and goldenrod blossoms, upon which they chiefly depend for food at this season. Farther south some of these butterflies hibernate and come out again in early spring.

It is well known that this butterfly has an odorous secretion, offensive to birds and other creatures that might otherwise feed upon it. I have often offered freshly caught specimens to dogs that were fond of eating other butterflies, but they have invariably refused to touch this species, showing very plainly by their facial expressions that the odor is to them very disgusting—probably much more so than to human beings.

Another American butterfly, the Viceroy (*Basilarchia archippus* Scudder=*Limenitis archippus*), which closely imitates the Monarch in form and color, though somewhat smaller, has not yet been recorded from Bermuda. See plate lxxxii; figures 6, 6*a*. This remarkable instance of imitative protective coloration has been fully discussed by several writers, and especially by Mr. S. H. Scudder.* The Monarch now occurs in nearly all temperate countries, in both hemispheres, and even in Australia.

Queen Butterfly. (*Anosia berenice* (Cram.)=*Danais berenice* Cram., Papil., pl. ccv; Sm. and Abbot, 1, pl. 7.)

FIGURE 125, PLATE LXXXIII; FIGURE 1.

This species is much less common. It was first recorded by Hurdis, May 15, 1849, who regarded it as a variety of the preceding. He states that it is finely spotted with white and lacks the black lines

* Butterflies of the Eastern United States and Canada, p. 120.

along the veins, but if so his specimens may have been a different species,* or the var. *strigosa.*

According to the notes of Miss Victoria Hayward, it is found not uncommonly all the year. She describes the color as darker than in *A. plexippus*, and the larva is said by her to have three pairs of long filaments, the additional pair being near the middle, on the 5th ring; the pupa is smaller, cream-color, tinged with green and dotted with silky golden specks on the front side, beside the semicircle on the ventral side.

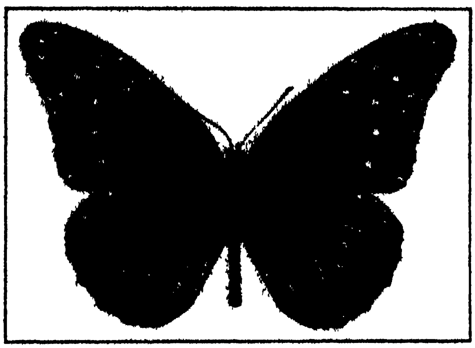


Figure 125.—Queen Butterfly (*Anosia berenice*, var. *strigosa*), male; upper side; ½ natural size; phot. by A H V.

The larva of typical *berenice* is described as pale violet, with transverse stripes of darker; a transverse band of reddish brown on each segment, divided by a yellow band; a longitudinal stripe of yellow along the feet; filaments brownish purple, a pair on the 2d, 5th, and 11th segments. It feeds on *Asclepias* and oleander.

The typical *berenice* (see Holland, Butterfly Book, p. 84, pl. vii, fig. 2, and fig. 3, var. *strigosa*) is smaller than *plexippus*, and decidedly darker; ground-color of wings above dark rufous- or tawny-brown, both pairs bordered with blackish-brown, wider on the hind wings, on which there may be no white spots, in the male; usually with two rows in the female; but var. *strigosa* usually has a single row of small white spots; on the fore wings there are many small spots of white near apex and two submarginal rows on the black band. The hind wings of the female beneath have wide brown borders to the veins, but in var. *strigosa* Bangs, they are bordered with a pale

* A southern butterfly that might well occur here (*Agraulis*, or *Dione*, *vanillæ*) is very similar in color, and might easily be confounded with this species by one not familiar with the butterflies.

line. Expanse, 2.65–3.75 inches. It is native of the southern United States, especially in the southwest. Florida; Panama; and Cuba, (Yale Mus.).

Pearly-eye Butterfly. (*Enodia portlandia* (Fabr.) Hubn.; Scudder =*Debis portlandia* Holland, p. 190, pl. xviii, f. 20, iii, fig. 16, larva=*Hipparchia andromache* Hubn., Say, etc., and in Jones.)

FIGURES 126, 127

Jones records a specimen taken in 1848 by Canon Tristram. I do not know of any record of its recent capture, but that is of no great importance as evidence, for the Bermudian insects have been little studied in summer. It is native of the middle and southern United States.

126 127

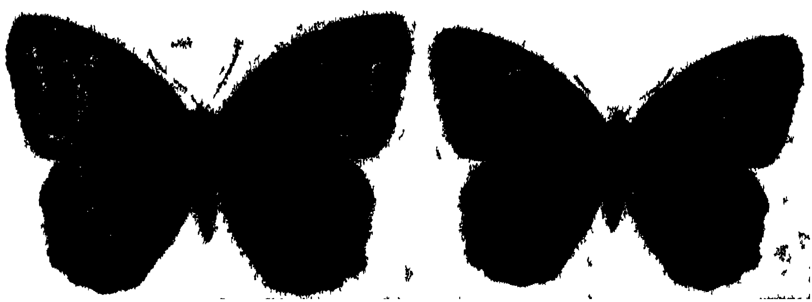


Figure 126.—Pearly-eye (*Enodia portlandia*), under side. Figure 127.—The same, upper side, about natural size, phot by A. H. V.

This delicate yellowish-brown butterfly has 4 to 6 oval, ocellated spots of blackish, bordered with orange or pale yellow, near the margin of each wing; on the under side the spots mostly have a small white center. Expanse of wings two inches. The larva feeds on grasses; it is green with two red processes on the head.

Sweet-potato Sphinx; Musk; Morning glory Sphinx; Rose-banded Sphinx. (*Phlegothontius cingulatus** = *Protoparce cingulata* = *Macrosila cingulata.*)

PLATE XCVII; FIGURES 1, 2.

The only common large sphinx. Its very large larva feeds on the leaves of the sweet-potato and other species of *Ipomœa*, and on wild jasmine. Geddes says that it feeds also on *Asimina triloba.*

* Mr. H. G. Dyar considers this a variety of the European species, *convolvuli* (L.), and writes the name *Phlegothontius convolvuli, var. cingulatus.*

Its abdomen is partially banded with several conspicuous bars of rose-red or pink, alternating with black, all interrupted dorsally by a median gray stripe; under side light gray. Its hind wings are concentrically banded with pink, light gray, and black; under side of wings dark smoky brown. It is common in the southern United States, from Virginia to Florida and Mexico, but very rare in New England. Expanse, 4 inches. The larva figured was taken in New Haven, Conn., on morning-glory (A. H. V.).

Musk; Pepper Sphinx; Tobacco-worm? (*Chærocampa tersa* Drury.)

FIGURES 128, 129.

This hawk-moth is easily recognized by its peculiar color. The front wings are yellowish brown with the narrow curved median lines alternately dark brown and buff; front edge and median streak dark brown; hind wings blackish brown with a row of five or six submarginal angular or wedge-shaped spots of light orange or yellow, with their bases next to the posterior border; base and edges yellow. Body yellowish brown above, with narrow orange stripes; patches of white at bases of wings; sides orange, with narrow brown lines; Expanse, 2.25 inches.

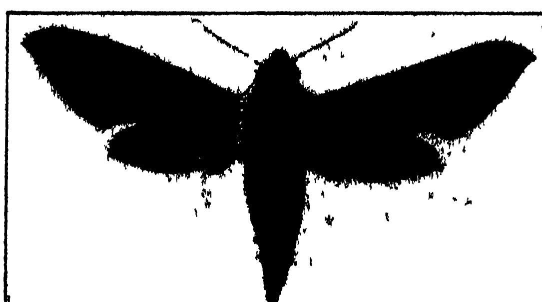


Figure 128.—Pepper Sphinx (*Chærocampa tersa*); 1⅓ natural size; phot. by A H V.

The larva, which is usually about 70^{mm} long when mature, is pale leaf-green, with obscure transverse dorsal lines of bluish green, and with seven conspicuous oblique lateral bars of orange-red, posteriorly edged with bright blue and anteriorly bordered with flake-white; spiracles white and orange; a curved line of orange-brown on the upper part of last three segments, the area above this line spotted with white; head light green with white spots, and with a band of

blue and orange like those of the sides; legs with white spots; caudal appendage slender, bluish with brown spots. A variety with brown ground-color also occurs. Pupa dark chocolate-brown.

This species is widely distributed from Maryland to the Gulf of Mexico, West Indies, and South America. Rare in Connecticut.

J. M. Jones, 1876, records it as common in Bermuda, the larva being known as "Tobacco Musk." Most authors do not give the tobacco as one of its food-plants. It feeds on various other plants.

129

129*a*

Figure 129.—Pepper Sphinx; *a*, larva; *b*, pupa, ⅞ natural size; phot. from colored drawing by A. H. V. Figure 129*a*.—Larva of Isabella Moth, nat. size, from Webster's International Dictionary.

Geddes also recorded it in 1894, so that it is doubtless fully naturalized. He states that the larva feeds on button-weed (*Spermacoce tenuior*). It has been found at New Haven, Conn., feeding on red-pepper plants, by A. H. Verrill, to whom I am indebted for colored drawings of the larva and pupa (fig. 129). It is possible, however, that Jones (who was not an entomologist) confounded the larva of this species with that of the common Tobacco-worm (*Protoparce*, or *Macrosila*, *Carolina*), though the latter has not been recorded.

It was taken by me in March, 1901. Fresh specimens were sent in October by Miss Hayward and L. Mowbray.

Silvery Sphinx. (*Sphinx argentata* = *Chlænogramma jasminarum* Bdv.) This rare species was recorded by Jones, 1876.

Isabella Moth; Wooly-bear. (*Pyrrharctia isabella.*) Figure 129*a*.

A living adult larva of this common, American moth was sent in November by Mr. Mowbray.

Wood Beauty; Pink-underwing Moth; Bella-moth. (*Utetheisa bella = Deiopeia bella* (L.) Figure 130.

This beautiful North American moth is usually common in August and September. It was first recorded by Hurdis, Oct. 10, and Nov. 17, 1847, and Aug. 17 to Sept. 12, 1854; also by Jones, 1876; and July to Sept., by Miss Hayward. The pink hind wings are bordered with black, and have a white line between the two colors. The fore wings are yellow or orange, with cross-rows of connected white spots, each centered with black. Its larva feeds on a variety of plants, including plum and cherry trees, elm, lupines, *Lespedeza*, *Crotalaria*, etc. It ranges from Nova Scotia and Maine to Florida and Mexico· Cuba and Panama (Yale Mus.). St. George's, Oct, L. Mowbray.

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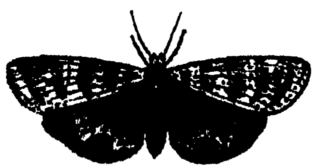

130*a*

Figure 130.—Pink-underwing Moth (*Utetheisa bella* (L.); nat. size; after Harris.
Figure 130*a*.—Mourning Moth (*Lycomorpha pholus*); × $1\frac{1}{10}$; phot. A. H. V.

Mourning Moth. (*Lycomorpha pholus* Fabr.) Figure 130*a*.

This American moth was recorded by Jones, 1876, as rare. Its larva feeds on lichens. Wings dark blue distally; saffron at base. Nova Scotia to Virginia.

Cut-worms; Grubs; Cut-worm Moths.

Agrotis ypsilon (Rott.); J. B. Smith, Revis., Bull. Nat. Mus, 25, p. 63, pl. iii, fig. 25, 1890;* Catal., p. 66=*A. suffusa* Butler=*A. telifera* Harris, Inj. Ins. Mass. Whole United States; Canada; Europe.

Peridroma incivis (Gn.); J. B. Smith, Revis., op. cit., p. 72, pl. iii, fig. 81; Catal., p. 70=*Agrotis incivis* Gn.; Walker; Grote; Morris, etc.; larva described, as *A. lubricans*, by French, in Canad. Ent., xii, p. 14. New England to California; Texas; Florida.

Feltia malefida (Gn.); Smith, Revis., op. cit., p. 122, pl. iv, fig. 56, Catal., p. 84=*Agrotis malefida* Gn.; Walker, Cat. Brit. Mus., Lep. Het., x, p. 328; Harvey, etc.

* Revision of the species of the genus *Agrotis*. This work contains full technical descriptions of all the species and modern generic divisions, with figures of the external genitalia, and details of synonymy.

Whole United States; Cuba.

Feltia annexa (Tr.); Smith, Revis. Noc., op. cit., p. 122; Catal., p. 84=*Agrotis annexa* Tr.; Stephens, Ill. Brit. Ent, Haust., ii, p. 117, pl. xxii, f. 2; French, Canad. Ent., xiv, p. 207, 1882. (Life-history.)

United States S. of New England; Mexico; South America; Europe.

FIGURES 181, *a*, *b*; 182. PLATE XCVIII

These and other related species are sufficiently troublesome to young garden crops. Some of them may have been indigenous, for Cut-worms were mentioned by Gov. Butler in 1619, as injurious to the crops; but they are all species easily introduced in the larval state, in the earth attached to the roots of living plants.

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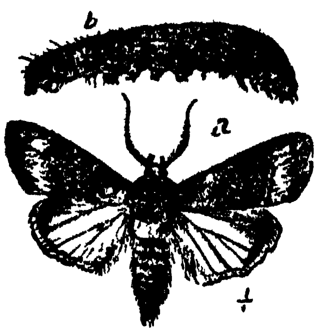

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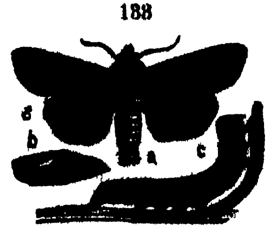

Figure 181 —Cut-worm (*A. ypsilon*); *a*, imago; *b*, larva; about natural size. Figure 182.—Cut-worm (*Feltia annexa*); *a*, larva; *a'*, its head; *b*, pupa; *c*, imago. Figure 183.—Army-worm (*Leucania unipuncta*); *a*, male imago; *b*, pupa; *c*, larva; both ⅚. Last two are from Webster's International Dictionary; after Riley.

The destructive larva called "the grub" by the farmers in Bermuda is probably the larva of four or more species of cut-worm moths, and some allied genera. According to the notes of Miss Victoria Hayward it is a nocturnal larva that attacks the young plants of potatoes, etc., especially of onions, often doing great damage to the latter. They are most abundant in January and February, but are active from December to June. They often destroy large numbers of seedling onions in the beds, and are so fond of Birds-eye Peas that these can hardly be planted safely before July. They are often caught in large numbers by hand, in the night, by the use of lanterns. This larva is silvery gray with four alternating stripes of

black and white along the back. This may be the larva of *F. annexa*, which is thus striped, but perhaps *A. ypsilon* is more abundant in some localities; they all have similar habits.

The larva of *A. ypsilon*, sometimes called the "Greasy Cut-worm" in the United States, is dark, dull, leaden brown, or blackish, with a faint, pale yellowish, broken line along the back, and a somewhat more distinct subdorsal line, below which, on each side, there are two other indistinct pale lines; about eight small glossy spots on each segment; length, 1.5 inches. Fig. 131, *b*.

The moth has the fore wings rather long and narrow; ground-color dark purplish brown with more or less of paler or luteous, especially on the distal fourth and on the cross-bands; reniform spot with a black sagittate dash from middle of outer edge; hind wings whitish or yellowish drab, with yellowish brown veins and marginal line; fringe white and with a pearly luster; antennæ of male strongly pectinate. Expanse, 1.5 to 2 inches, or 36–52^{mm}. Fig. 131 and plate xcviii, figure 3.

Peridroma incivis has the ground-color of the thorax and fore wings dark or light ash, varying to reddish gray; the wings with narrow wavy cross lines and scattered specks of blackish; orbicular spot often lacking, when present edged with brown and white, center brownish; reniform spot large, distinct, lunate, margined with white and yellowish, centered with brown; under wings purplish white or pearly iridescent white, translucent, with anterior and distal margins and veins often dusky. Males are darker than females. Expanse, 32–38^{mm}. Plate xcviii, figure 4.

The mature larva* may have the ground-color either green or brown; in the latter form the body is of a brown color like dead grass, with a broad white band, mixed with red, below the stigmata; an obscure double lateral band of brown; three obscure dorsal and subdorsal rows of black specks; cervical shield with three whitish lines; head luteous with blackish lines. The green form has the head green, with black lines; body green mottled with small brown and whitish specks; a double dorsal and four lateral lines of greenish black; substigmal line broad, red, upper edge brown. Eggs ribbed, laid in large clusters on leaves. Larva feeds on grass.

Feltia annexa, fig. 132, has the ground-color of fore wings clay-yellow, with a darker costal patch distally and a basal dark patch; veins blackish; orbicular and reniform spots small, connected by a

* Detailed descriptions of eggs and larvæ in all stages are given by Mr. H. G. Dyar, Proc. U. S. Nat. Mus., xxiii, p. 273, 1900.

regular black dash; under wings nearly pure white. Expanse, 38–45^{mm}.

Feltia malefida also has a pale clay-yellow ground-color, mixed with gray and with dark brown costal and terminal patches; a distinct, large, dark, claviform spot; orbicular spot flask-shaped, elongated, centered and edged with blackish; reniform broad, edged with black and centered with dark brown; no black dash between them; under wings nearly white, sometimes with buff or dusky veins and margins. Expanse, 40–45^{mm}. Plate xcviii, figure 5.

American Army-worm. (*Leucania unipuncta* (Haw.); Flint, in Harris, ed. ii, p. 627, figs. 274–6; J. B. Smith, Cont. Monog. Noct., Proc. U. S. Nat. Mus., xxv, 177, 1902.)

FIGURE 188.

This destructive insect was recorded by Jones as common in 1876, but I do not know whether it has ever proved so destructive to grass and cereal crops as it often does in the United States. Miss Victoria Hayward states that a larva, locally called "Army-worm," is very injurious to the common potato some seasons, but its identity is uncertain.

The larva of *L. unipuncta* is dark gray, with three narrow, yellowish dorsal stripes, and a wider darker yellow one on each side; head brownish yellow, lined with brown, and with a V-shaped black mark on the front. Length, about 1.5 inches.

The moth has the fore wings dull russet-drab or fawn-color, with a small, distinct, white spot in the center, and a dusky oblique stripe at the tips, the surface sprinkled with black dots, two very small pale yellowish dots near the white spot; hind wings smoky brown, translucent. Expanse, 1.75 inches. Canada to Colorado; Florida; Mexico; and South America.

Leucania antica Walker was also recorded by Butler, 1884, as the commonest moth in the Challenger Expedition collections. It is a West American species according to Walker. The larvæ are perhaps among those called "Army-worms" in Bermuda. We should expect that the southern Army-worm of the United States (*Laphygma frugiperda*) would also be found here, but it has not been recorded.

Beet Army-worm. (*Laphygma exigua* (Hub.) = *L. macra* Guen., Noct., i, p. 157; Butler's List, etc.)*

FIGURES 134, *a–f*.

This species, which was first recorded by Butler, 1884, as *L. macra*, is doubtless one of the common injurious species grouped together by the farmers under the general name of "army-worm." Most likely it is the army-worm that injures the common potato to a considerable extent in some seasons. In the western United States it is chiefly injurious to the Sugar Beet, but will also feed upon common beets, potatoes, onions, corn, and peas, and upon various weeds, especially pig-weeds (*Amaranthus* and *Chenopodium*), mallows, ground plantain, etc.

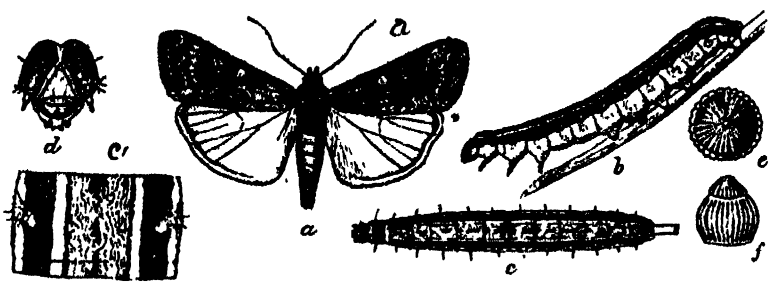

Figure 134.—Beet Army-worm and moth (*Laphygma exigua*); *a*, moth; *b*, *c*, larvæ; nat. size; *c'*, dorsal surface of the segment bearing 1st prolegs, enlarged; *d*, its head enlarged; *e*, *f*, eggs much enlarged; after Chittenden.

The mature larva has a greenish or olivaceous ground-color, with a broad dorsal stripe, dotted and streaked with greenish or blackish, darkest in the middle; two pale stripes on each side, separated by a darker band, varying from gray to black, dotted with white; head green, olivaceous, or smoky brown, with three whitish longitudinal lines; feet greenish. Length about 1.3 inch (30 to 34^{mm}).

The moth is, in general, pale ochreous brown; the round spot on the fore wings is pale yellowish; the reniform spot is less conspicuous, with a darker center; submarginal line pale; a marginal row of dark specks.

It is an Old World insect, now widely diffused in warm latitudes. It is believed that it was first introduced into the United States via the Hawaiian Islands and the Californian coast, whence it has

* For synonymy and a full life-history, see F. H. Chittenden, Bull. No. 33, U. S. Agric. Dep., Entomology. New Series. 1902.

migrated to New Mexico, Arizona, Colorado, etc. Probably it was introduced into Bermuda directly from southern Europe, by eggs on growing plants, or else in the adhering earth, while in the pupa.

Commelina Owlet Moth. (*Prodenia commelinæ* (Sm. and Abbot, ii, p. 189, pl. xcv, as *Phalæna*; Gn.; J. B. Smith, Catal. Noct., p. 169, 1893). Figures 135, *a–d.*

The striped larva of this species feeds on various plants besides *Commelina*, including sweet potato, asparagus, violets, raspberry, and cotton.* It is found in the southern United States, northward to Washington, D. C., and Illinois. The moth has a ground-color of rich, dark brown on the fore wings, variegated with transverse lines of black, and complex markings of purplish brown and dull yellow; hind wings pale pearl-gray, with violet iridescence.

The larva has the ground-color olive or greenish brown, finely lined with dark gray and brown, the dorsal surface with a double row of triangular velvety black, or sometimes greenish spots, and a central row of small yellow dots. It was first recorded by Jones, 1876.

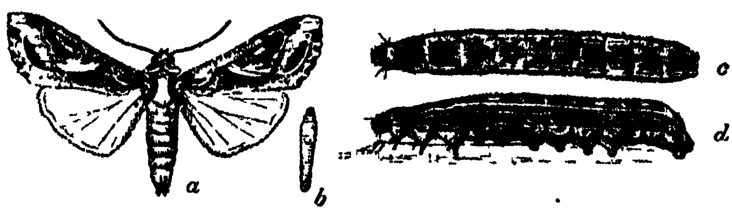

Figure 135.—*Prodenia commelinæ*; *a*, moth; *b*, young larva; *c*, mature larva, dorsal view; *d*, same, lateral view—all slightly enlarged; after Chittenden.

Grass-moth. (*Remigia repanda* (Fab.) = *Remigia latipes* Gn.; Smith, Catal. Noct., p. 363† = *R. marcida* (var.) Gn.; Walker, Catal., xiv, p. 1495.) Plate xcviii, figure 6.

Fore wings buff or light yellowish brown, specked and transversely irregularly lined with darker brown, and with a costal, apical, and distal patch and a tranverse band of darker brown, the latter edged internally with a lighter buff band; the brown linear marks are

* For full description, see F. H. Chittenden, Bull. 27, new series, U. S. Dep. Agriculture, 1901.

† Probably the *Pernigia latipes* of Jones was a typographical error for *R. latipes*. Mr. Dyar gives me these additional synonyms: *disseverans* Walk.; *perlata* Walk.; *indentata* Harv.; *hexastylus* Harv.; *Texana* Mor.

crooked or wavy and mostly geminate; a round spot edged with the same. Hind wings have nearly the same ground color proximally, with a slightly paler transverse band, bordered distally with a rather darker wide brown band; margin pale. Expanse, about 38^{mm}, or 1.5 inches.

The mature larva* is slender, nearly cylindrical, smooth; prolegs on segments 9, 10, 13; body yellowish white with many brown or blackish, mottled, double lines; dorsal line reddish brown, double; subdorsal composed of six black lines, with a black spot between the 5th and 6th segments; four reddish lateral lines; a pair of black lines just above the stigmata; a red one along the stigmata; and a pair of red ones below them; ventral stripes darker; spiracles with black edges; head white, lined with faint brown and reddish markings. It is nocturnal in habits; when disturbed it curls itself up, the body forming an abrupt angle at the 5th joint, the thoracic feet touching the prolegs. Common according to Jones. Feeds on grass.

Whole United States east of Rocky Mountains; Labrador; Cuba; South America.

Plusia ou Gn.; J. B. Smith, Catal. Noct., p. 252, 1893; Morrison, Proc. Bost. Soc. N. H., xvii, p. 210=*P. fratella* Grote, Bull. Buffalo Soc. N. H., xi, p. 161. Plate xcviii, figures 7, 8.

Fore wings lustrous yellowish brown, specked and variegated with darker brown, and with a subapical patch of dark brown; faint oblique cross-bands of gray; silvery spot bilobed, bordered externally with dark brown. Under wings shining yellowish or golden brown with a distal band of dark brown and a whitish margin. Under side of wings yellowish brown, faintly banded with darker; body tawny brown. An elegantly colored species. Expanse $32–40^{mm}$.

The larva is undescribed; food-plants are not known.†

Range, New England to Oregon, California, Texas, Florida, etc.

Green Geometrid Moth. (*Synchlora denticulata* Walk. (?)=*excurvaria* Packard).

Mr. H. G. Dyar thinks that our two specimens are probably this species, but they are too much injured for positive identification. The body and wings are bright, light green, the fore-wings crossed by two irregular, narrow, faint whitish lines. Taken in summer. T. G. Gosling. Larva eats leaves and flowers of various weeds.

* For full descriptions of all stages, see H. G. Dyar, Proc. U. S. Nat. Mus., xxiii, pp. 276–8, 1901.

† See Addenda.

Gypsochroa sitellata (Gn.) = *Philereme albosignata* Pack.; Jones.* Plate xcviii, figure 9.

Both pairs of wings elaborately variegated and mottled with dark brown and pale buff or brownish yellow; costal margin of fore wings with alternate irregular spots of the two colors; an indistinct band of the lighter color; a narrow, distal, marginal line of alternating blackish brown and white spots; body colored like the wings. Expanse 30^{mm}, or 1.25 inches. The larva, which feeds on *Pisonia aculeata* (t. Dyar), in Florida, is green mottled with irregular lines and spots of darker yellowish green and specked with blackish.

Melon-moth; Melon-worm. (*Diaphana hyalinata* L = *Margaronia hyalinata* = *Eudioptis hyalinata* in Geddes.)† Figure 136.

This moth is a beautiful insect, with shining white wings, bordered with black; the abdomen is tufted at tip with buff, edged with black and white. The young larvæ eat the leaves of melons, squashes, and cucumbers; older ones burrow in the stalks and fruit.

187

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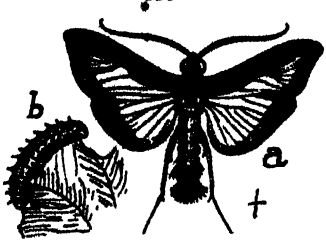

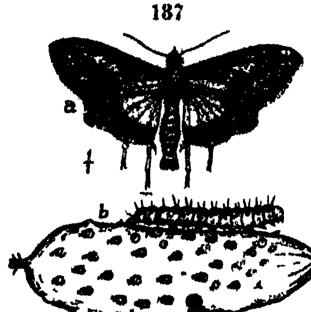

Figure 186.—Melon-moth; *a*, imago, nat. size; *b*, larva. Figure 187.—Cucumber-moth; Pickle-worm (*Diaphana nitidalis*); *a*, imago, nat. size; *b*, larva and its burrow in a young cucumber. Both from Webster's International Dictionary; after Saunders.

Mature larvæ are translucent yellowish green, with scattered hairs; length, 30^{mm}. It is often very injurious in the southern United States. Recorded by Jones in 1876 as abundant. Oct., L. Mowbray.

Pickle-worm or *Cucumber-moth* (*Diaphana nitidalis* = *Margaronia*, or *Eudioptis*, *nitidalis* (Cram.), fig. 137, whose larva bores in

* Mr. H. G. Dyar has given me the following synonymy: *Gypsochroa sitellata* Gn.) = *hassitata* Gn.; Dyar, Psyche, ix, p. 59, 1900 (life history) = *impauperata* Walk. = *Philereme albosignata* Pack.; Jones, 1876.

† Mr. H. G. Dyar gives me the following additional names for this species: *Botys lucernalis* Hubn.; Jones; *marginalis* Stoll.; *hyalinatalis* Guen.

young or half-grown cucumbers, often doing much damage, is also said to occur here, but we did not obtain specimens. The larvæ also bore in melons and squashes, like those of the preceding species.

Sweet-potato Fire-worm. (*Hymenia fascialis.*) Figures 138, 139.

According to the notes of Miss Victoria Hayward the Sweet Potato vines in midsummer are often very badly damaged by the green larvæ of a small pyralid moth called the "fireworm." It eats out the parenchyma, quickly reducing the leaf to a skeleton.

Some of these larvæ which were mailed to me by her at Bermuda, August 8th, had become pupæ when they reached me, August 12th; on the 13th the imago emerged from one of them. Thus the duration of the pupa stage may be as short as four or five days.

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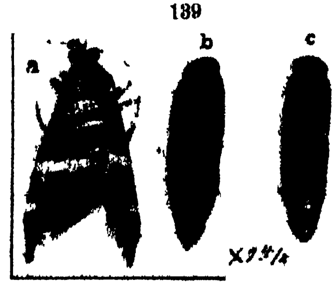


Figure 188.—Sweet-potato Fireworm Moth; leaf as skeletonized by the larvæ: *a*, *b*, *c*, pupæ; *d*, moth, ×1¼ Figure 139.—The same; *a*, moth; *b*, *c*, pupæ, ×2¼. Phot by A. H V, 1902, from life

This small moth is rather prettily marked. The ground-color of the body and wings above is coppery-brown, with white markings; front of head and a ring behind the eyes white; abdomen crossed by five or six bars of white, the two anterior wider; under side buff, with three rows of black spots. Both pairs of wings are crossed by a nearly median bar of white, which, when the wings are folded, runs directly across in a straight line, coincident with the basal white bar of the abdomen, but does not quite reach the costal margins of the fore wings, ending in a point, with a subterminal, angular, hook-like projection, directed backward; midway between this white bar and the apex of the wing is a white transverse spot, bordered with black, and reaching the edge of the wing, with a few specks of white at its inner end, and a blackish patch beyond it;

terminal fringe with alternate patches of black and white, mostly white on the hind wings, and with a narrow basal band of white, edged on both sides with a black line. Legs buff; the anterior pair with narrow bands of black; antennæ brown. Length of moth, with folded wings, 10^{mm}; of pupa, 9^{mm}. Determined by Mr. Dyar.

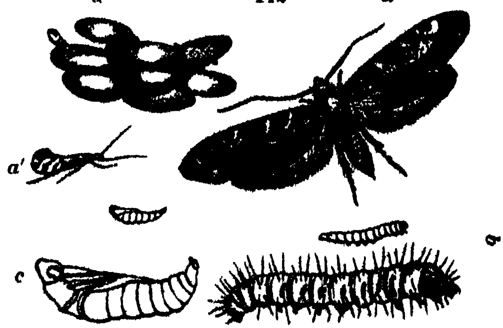
Syngamia florella Cr.

This small, conspicuously colored, pyralid moth has been identified by Mr. H. G. Dyar, from a small lot of moths received in the summer of 1901, from Mr. T. G. Gosling. Its front wings are purplish brown, crossed by three large, conspicuous, golden-yellow spots; under wings darker brown, with a subbasal patch and a subterminal ovate spot of orange-yellow or deep golden yellow. It is also known from Key West. St. George's, Oct., L. Mowbray.

Grass Moth. (*Nomophila noctuella* Walker); E. B. Felt, Canad. Ent., May, 1893, vol. xxv, p. 193, figs. (life history).*

The larva of this common gray pyralid feeds on clover and various grasses, and is often very injurious. Widely diffused in United

d 142 a



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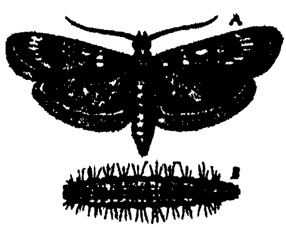

Figure 141.—Fig-moth (*Ephestia cahiritella*); enlarged 2; A, imago; B, larva
Figure 142.—Grain or Wolf-moth (*Tinea granella*); *a*, imago, enlarged; *a'*, the same, nat. size; *b*, larva, nat. size and enlarged; *c*, pupa, nat. size and enlarged; *d*, infested grain. After Packard. 141 from Webster's International Dictionary; after Chittenden.

States and Canada. Jones recorded it as common in 1876; it was also in Geddes' list. We took it in April, 1901. It was taken by Miss Hayward, Aug., 1902, at lights.

* Mr. Dyar gives me the following synonyms: *hybridalis* Hub.; *indistinctalis* Walk.; *helvolalis* Maasen.

Bee-moth; Wax-moth. (*Galleria mellonella = G. cereana.*)

FIGURE 140.

Common and very injurious to the honey bees, its larva destroying both honey and comb.

Abundant both in Europe and North America.

Fig-moth; Raisin-moth. (*Ephestia cahiritella* Zell.) Figure 141.

The larva of this widely diffused moth feeds on dried figs, prunes, raisins, dry currants, nuts, chocolate, meal, and various other dried

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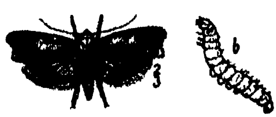

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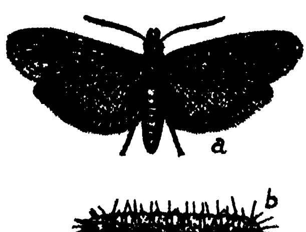
Figure 140.—Bee-moth (*Galleria mellonella*); *b*, larva. Figure 145.—Angoumois Grain-moth (*Sitotroga cerealella*), × 1½ Both from Webster's International Dictionary. Figure 145*a* —Corn infested by *S. cerealella*; after Riley.

food-stuffs. The color of the moth is gray, with whitish markings on the fore wings; expanse 15 to 20^{mm}.

143



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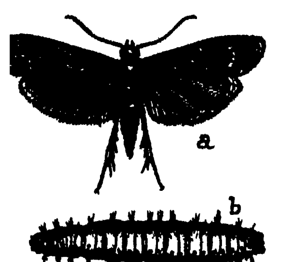

Figure 143.—Meal-moth (*Plodia interpunctella*); *a*, imago; *b*, larva; both enlarged 2¼. Figure 144.—Flour-moth (*Ephestia Kuehniella* Zell.), × 1½; *b*, larva, × 2⅓; from Webster's International Dictionary; after Chittenden

Meal-moths; Flour-moths; Grain-moths. (*Pyralis farinalis. Tinea granella*, fig. 142. *Plodia interpunctella*, fig. 143. *Ephestia Kuehniella*, fig. 144. *Angoumois Grain-moth* or "*Fly-weevil*" = *Sitotroga*, or *Gelechia, cerealella*, fig. 145.)

All these small moths, and apparently others related to them, seem to be common, as in most other warm countries. They all feed on stored cereals of various kinds, including flour, meal, bran, stored

grain, and ship-bread, and often do great damage to stores of provisions in forts, ships, and warehouses, as well as in flour-mills.

Plodia interpunctella has the wings light, dull gray, the distal part of the fore wings brownish red or coppery.

Common Clothes-moth. (*Tinea flavifrontella* Pack. or *pellionella* L.)

FIGURE 146.

Very abundant and destructive in houses. The larva lives in a portable tube usually made of wool fibres.

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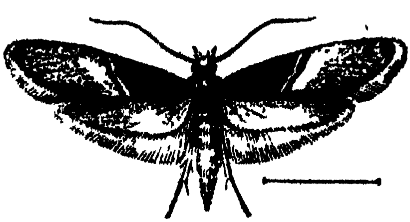
Figure 146.—Clothes-moth (*Tinea flavifrontella*); *a*, imago; *b*, larva; *c*, portable case. Figure 147.—Tapestry-moth (*Tineola biselliella*), ×3; after Riley. First from Webster's International Dictionary.

Tapestry-moth; Webbing-moth. (*Tinea*, or *Tineola*, *biselliella.*)

FIGURE 147.

Less common than the last, but capable of doing great damage to woolens, furs, and feathers. Its larva does not make a portable tube,

147*a*



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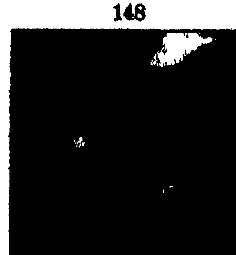

Figure 147*a*.—Tapestry-moth (*T. tapetzella*); ×3¾; after Riley. Figure 148.—Portion of leaf of Sweet-potato, showing mines of leaf-miner; ×1¼; phot. A. H. V.

but lives in a silken web on the substance that it is destroying. It is partial to furs and feathers, but eats also woolen and hair goods. The moth has uniform, pale ochreous yellow fore wings.

Tapestry-moth; Tube-dwelling Clothes-moth. (*Trichophaga*, or *Tinea*, *tapetzella* L.) Figure 147*a*.

This destructive moth doubtless also occurs, but we did not obtain it. Its tube is not a portable case, but rather a long, crooked tunnel or gallery. The moth has the basal half of the fore wings black; the distal half white.

Leaf-miner of Sweet Potato. (*? Bedellia minor* Busck, t. Busck.) Figure 148.

A minute tineid, about 3^{mm} long, plain silvery, with the tips of the wings curved upward and fringed with long scales, whose larva mines in the leaves of sweet potato, causing irregular, blister-like, yellowish spots, $2-4^{mm}$ in diameter. Imago emerged Aug. 26, from leaves mailed from Bermuda by Miss Victoria Hayward. Mr. Busck, who has examined it, identifies it doubtfully as the above species, described from Florida, on morning glory.

Several other undetermined tineids were sent by Miss Hayward.

Gelechia bosquella Chamb., Bull. U. S. Geol. and Geog. Survey, iv, p. 87. Wals., Tr. Am. Ent. Soc., x, p. 178.

This small tineid sent by Mr. Louis Mowbray in October, is grayish black and silvery white; on the wings the silvery white covers a basal patch, the posterior margin, and two small costal spots; legs banded with the two colors. Length, $\cdot 6^{mm}$. Identified by Mr. Busck.

Grass Web-worm. (*Crambus laqueatellus* Clem. ?)

Mr. H. G. Dyar has identified one specimen, in poor condition, taken in summer by Mr. T. G. Gosling, as probably this species, but it may be some other closely related species, for it is too imperfect for accurate determination.

The following Lepidoptera, collected in Bermuda in April by the Challenger Expedition, were recorded by A. G. Butler, Ann. Mag. Nat. Hist. (5), xiii, p. 183–188, 1884:

Leucania antica Walker, Catal. Ex. Lepid., ix, p. 100, 1856.*

* According to Walker its colors are as follows:—Thorax with several brown bands; abdomen very pale fawn color; fore wings with costa and interior border speckled with black, with some brown dots in the disk, with the usual exterior band of black dots, more numerous than usual; fore part of exterior border brownish; hind wings whitish, with black marginal dots. Length of body, .5 inch; of wings, 1 inch. "West coast of America." South American.

Laphygma macra Guenée ;=*L. exigua* (Hub.). See p. 778.

Perigea subaurea Guenée ; a W. Indian noctuid.*

Plusia ou Guenée, Noct., ii, p. 96, 1852. Florida, etc. (See p. 775.)

Remigia marcida Guenée, iii, p. 317=*R. repanda.* (See p. 774.)

Thermesia monstratura Walker, Cat. Lep., xv, p. 1564, 1858.†

Margaronia jairusalis Walker, op. cit., xviii, p. 524, 1859=*Glyphodes jairusalis* Hampson, Proc. Zoöl. Soc. London, 1895, p. 733. S. America (t. Dyar in letter).

Stenopteryx hybridalis (Hübner), Pyral., p. 29, pl. xvii, fig. 114, (as *Pyralis*)=*Nomophila noctuella*, (t. Dyar.) (See p. 778.)

Chærocampa tersa (Drury), Ill. Exot. Ent., i, p. 56, pl. 28, fig. 3.

Junonia cœnia Hübner. See above, p. 762.

Probably most of these are introduced species.

G. Geddes' list (Entomol. Soc. Ontario, 25th Ann. Rep., p. 25, 1894, collected January to May) adds the following to Jones' list :

Botys adipaloides Grote and Rob., Des. Amer. Lep., p. 26, fig. 19 =*Pyrausta orphisalis* Walk. (t. Dyar). U. States ; common.

Plusia, sp., imago feeding on flowers of wild mustard (*Sinapis nigra*). Perhaps=*Plusia ou* Guenée.

g.—*Trichoptera.* (Caddis-flies.)

Insects of this group are not common in Bermuda, but Dr. H. Hagen identified one North American species (*Hallesus maculipennis*) from the collection of J. M. Jones, 1876.

h.—*Neuroptera.* (Ant-lions ; Lace-wings.)

Lace-wing Fly; Golden-winged Fly; *Bright-eyes.* (*Chrysopa rufilabris* Burm.)

FIGURE 149.

This Lace-wing Fly was received from Mr. Louis Mowbray early in November. The body is light green with a narrow pale yellow dorsal line on the abdomen and a pale lilac streak on the thorax ;

* This moth is ferruginous, with the thorax blackish and the abdomen grayish; fore wings with three yellowish fasciæ, and speckled with yellow. Antilles and Brazil ; not yet known from the United States.

† *T. monstratura.* According to Walker its characters are as follows :—Wings of ♀ slightly speckled with black ; oblique line straight, black, diffuse, extending from ⅔ the length of inner border of hind wings to tip of fore wings ; middle line black, undulating; submarginal line indicated by black points; fore wings with the interior line black, undulating, a black oblique streak extending

head in front of eyes and mouth-parts red; upper side of head and bases of antennæ greenish yellow; eyes brown; palpi dusky; legs

Figure 149.—Lace-wing Fly (*Chrysopa*), nat. size, with its eggs mounted on silken stalks; *c*, larva: American species. From Webster's International Dictionary. In a cut not distinguishable from the Bermuda species.

pale green; wings hyaline, strongly iridescent, the principal veins yellow, the cross-veins light green. Length, 10^{mm}; to tip of folded wings, 15^{mm}.

The larva of a species of this useful genus, was observed by us, feeding on plant-lice. It may be *rufilabris* but was not identified.

Ant-lion. (*Myrmeleon*, sp.)

FIGURES 150, 151.

An Ant-lion was recorded as in the collection of J. M. Jones, 1876,

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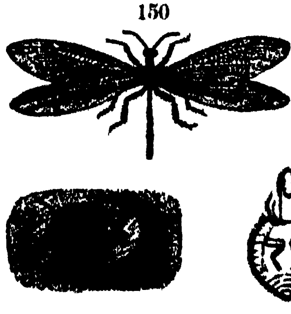

151

Figure 150.—American Ant-lion (*Myrmeleon*), nat. size, with its larva and pit-fall. From Webster's International Dictionary. Figure 151.—Larva of Bermuda Ant Lion; *a*, dorsal; *b*, ventral view: ×9. Phot. from nature, by A. H. V.

but the species has not yet been determined. The figures on cut 150 are from a New England species, for generic characters only.

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from the costa to the oblique line; round spot black, point-like; reniform spot large, unusual in form, broader than long, edged with black. Length of body .54 inch; of wings, 1.38. St. Domingo. Not North American. According to Mr. H. G. Dyar (in letter) the genus is a broad-winged noctuid near *Anticarsia*.

Larvæ of a species apparently of this genus were sent to me by Mr. T. G. Gosling, in 1901. Its body is dark tawny brown, thickly covered with short, stiff, black hairs above and below; they form transverse rows on each segment of the abdomen, but there are also clusters of somewhat longer ones, about five clusters on each segment, forming a median, two dorsal, and two lateral rows; those in the lateral row distinctly longer, but hairs are scattered between the groups, and also on the thorax, head, jaws, and legs, above and below; jaws orange-brown, lighter than body, but darkened at tip. Length of largest, about 5mm. See figure 151.

i.—Coleoptera. (Beetles; Weevils.)

The earliest writers mentioned only one beetle; this when crushed was said to give out a fragrant odor.* It was doubtless a native species, but I do not know that it has been identified in modern times. Possibly it was the common "Hard-back."

In spring, when we were in Bermuda, comparatively few beetles were active. Very few could be found on flowers. Several were found under stones and rubbish. No doubt many more additions to the list could be made in summer. A number of our beetles, which are still undetermined, cannot be included.

Corn-weevil; Grain Weevil. (*Sitophilus granarius* (L.) = *Calandra granaria* of most writers.) Figure 152.

As early as 1622 this small European weevil was mentioned as very destructive to corn, especially after it was stored, but it had undoubtedly been introduced from England by the ships, in stores of grain or meal, a few years earlier. In the early laws it is often mentioned from 1622 to 1650. Governor Butler relates that in consequence of certain lazy and indolent persons neglecting to husk their corn, in order to indulge in dissipation on the arrival of the magazine ship, it was discovered that their corn was much less damaged by the weevils than that which had been carefully husked and stored by the more industrious people (1622). This weevil is supposed to have been the European Grain Weevil, which infests wheat, flour, meal, corn, etc., in nearly all countries. It still attacks the

* Strachy says: "A kind of *Melontha*, or black beetle there was, which bruised, gave a savour like many sweet and strong gums punned together."

corn in Bermuda. It is nearly uniformly blackish, while the Rice Weevil has four reddish spots on the elytra.

Rice-weevil. (*Sitophilus*, or *Calandra, oryzæ.*) Figure 153. This also destroys corn and grain, etc., as well as rice. It is now common and may also have been present in the early years.

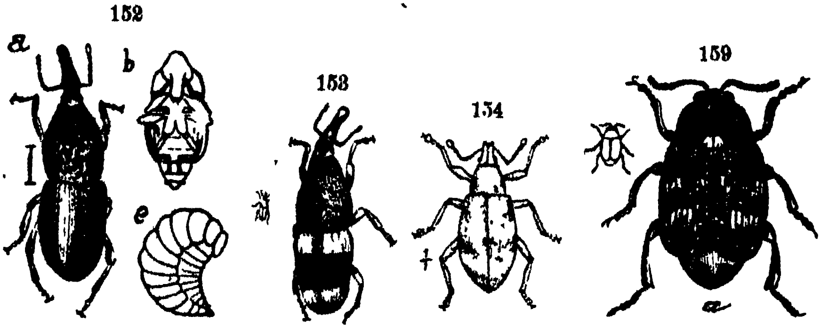

Figure 152.—Grain Weevil (*Sitophilus granarius*), natural size and enlarged; *c*, larva, *b*, pupa, much enlarged Figure 153.—Rice Weevil (*Calandra oryzæ*), much enlarged. Figure 154.—Onion Weevil (*Epicærus imbricatus*), × 1½. Last two from Webster's International Dictionary Figure 159.—Pea Weevil (*Bruchus pisorum*), natural size and enlarged, after Riley.

Imbricated Snout-beetle; *Onion Weevil.* (? *Epicærus imbricatus.*)

FIGURE 154.

This weevil, which is not only destructive to onions but also to cabbages and various other crops, appears to be common, though we took only a single specimen. It attacks the bulb of the onion. In Miss Victoria Hayward's MSS. notes there is an account of a "Cabbage-beetle" which may be this species. It is found throughout the middle and southern United States; New York to Texas.

A similar weevil, sent by mail in August by Miss Hayward, is bronzy or pearl-gray, closely covered with minute scales which reflect iridescent colors, the most prominent colors being pearly green, golden yellow, and pale blue, according to the light. The elytra are covered with close punctate sulci, but have no dark bands. Length, 12^{mm}.* Plate xcviii; figure 10.

Another weevil, of the genus *Lepyrus*, was recorded by Jones, 1876. We also collected several other undetermined species, one of

* Mr. E. A. Schwarz, who has examined the specimen, states that it belongs to the genus *Diaprepes* very near *D. famiiliaris* Oliv., of the family Otiorhynchidæ.

which is a small, black, tuberculate species of the genus *Anchonus* (t. Schwarz). Fig. 155*a*.

*Coffee-bean Weevil.** (*Aræocerus fasciculatus* DeG.) Figure 156.

This is a small thick-set beetle, with a vertical head and strong jaws; head orange-brown; prothorax orange-brown in front, with 3

155

155*a*

Figure 155.—Two Bermuda Coleoptera; *a*, Beetle (*Chrysobothris impressa* Fabr.); *b*, Weevil, ×1½. Figure 155*a*.—Small Black Curculio (*Anchonus*, sp.); ×9 Phot from nature by A. H. V.

blackish patches posteriorly; elytra varied with dark brown, grayish and ochreous, each with 6 whitish lines, interrupted by dark brown

156

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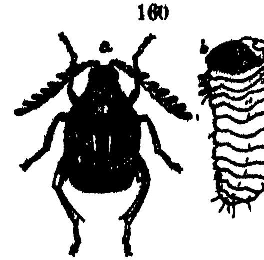

Figure 156.—Coffee-bean Weevil; *a*, imago; *b*, pupa; *c*, larva; ×8. Phot. from Bermuda specimens by A. H. V. Figure 160.—Cow-pea Weevil (*Bruchus Chinensis*); *a*, imago; *b*, larva; ×8. From Webster's International Dictionary; after Chittenden.

spots; two larger whitish spots on the basal end, one lateral and one at the inner basal margin, so that it forms with its mate a single median spot; under side brownish yellow; legs yellow, with narrow

* Fully described by Chittenden, Bull. U. S. Nat. Mus., new series, No. 8, p. 86, figure 9, 1897. Recorded from Bermuda by Dahl, Plankton Exp., i, part 1, p. 108.

dark bands at joints. Found by us in a dry calabash. The body exceeds the elytra, the latter are strongly sulcate, and each has two low subbasal bosses.

It infests not only the coffee-bean, but also cocoa-beans; mace, etc. It occurs in the southern United States, West Indies, Central and South America, Liberia, etc.

Tenebrionids; Meal-beetles; Meal-worms, etc.

This group is represented by the universally diffused Meal-worm (*Tenebrio molitor*), fig. 157, and by several other species, among which are *Phaleria testacea* Say, found under decaying rubbish on the sea-shore, and *Blapstinus metallicus* (Fab.) Lec., found in similar places, but less common. The latter is ovate, shining bronzy black, with rows of punctate dots on the elytra; prothorax minutely punctate; antennæ slightly clavate. Length, 5^{mm}.

A species of *Opatrinus* and *Diaperis affinis* also occur commonly, according to Jones. Heilprin records *Opatrinus anthracinus*, on the authority of Dr. Horn.

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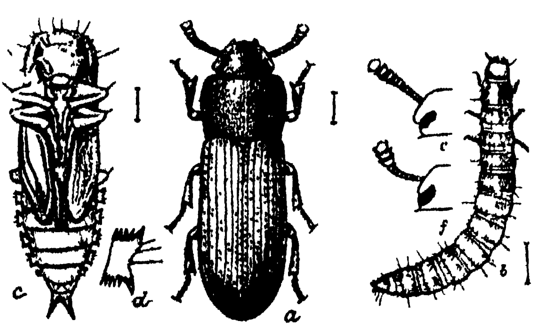

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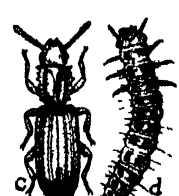

Figure 158.—Flour-beetle (*Tribolium confusum*); *a*, imago, ×9; *b*, larva, ×9; *c*, pupa, ×7; *d*, abdominal tubercle, much enlarged; *e*, antenna; *f*, Rusty Flour-beetle (*T. ferrugineum*), antenna, much enlarged; after Chittenden. 161.—Flour-beetle (*Silvanus Surinamensis*); *c*, imago; *d*, larva, ×12; 161, from Webster's International Dictionary; after Chittenden.

Flour Beetle. (*Tribolium confusum* Duv.) Figure 158.

Several small beetles occur here in imported flour and meal. One seems to be this species, which is often very injurious to flour and other prepared cereal foods in the United States, often doing much damage. The beetle is brown; 3 to 4^{mm} long, with the body flattened, and the sides of the head angular, outside the eyes.

Rust-colored Flour-beetle. (*Tribolium ferrugineum* Fabr.) Figure 158, *f.*

Mr. Geo. A. Bishop reports the occurrence of this species, also, in stored corn and beans. It also feeds upon meal, flour, and rice. It closely resembles *T. confusum*, in size and color, but has more clavate antennæ, the club 3-jointed, and a narrower head, the sides not projecting beyond the eyes.

Silvanus Surinamensis (fig. 161) is reported to occur, but we did not secure specimens for study. It is a slender, flattened, chocolate-brown Flour-beetle, only about 2.5^{mm} in length, of the family Cucujidæ. The sides of the prothorax are serrated.

Bruchidæ. This family is well represented by the *Bean-weevil* (*Bruchus obtectus* S., fig. 158*b*);)*Pea-weevil* (*Bruchus pisorum* L.= *B. pisi* L., figs. 159, 159*a*), which are common and were probably early introductions from Europe in the magazine ships.

Cow-pea Weevil. (*Bruchus Chinensis* L.) Figure 160.

This small beetle is reported by Mr. Geo. A. Bishop as occurring in Bermuda. It is common in the middle and southern United States, and most warm countries.

It infests not only cow-peas, but various other kinds of peas and beans, often becoming very injurious, utterly destroying large quantities.

159*a*

158*b*

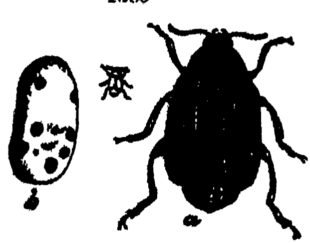

Figure 159*a*.—Pea-weevil (*B. pisorum*); *a*, beetle, side view, much enlarged; *b*, pea from which it emerged, nat. size; *c*, *d*, larvæ, enlarged; after Riley. Figure 158*b*.—Bean-weevil (*Bruchus obtectus*); *a*, imago, much enlarged; *b*, infected bean; after Riley.

Chrysomelids; Leaf-beetles; Flea-beetles; Potato-beetles, etc.

A few undetermined species of this family were observed, and doubtless many more occur. Among them, according to the statements of the farmers, is perhaps the striped Melon or Squash Beetle

(*Diabrotica vittata*). We were also told that the potatoes are often injured by a leaf-beetle, but could not obtain authentic specimens of it. According to the notes of Miss Hayward, an insect, apparently of this family, proves very destructive to the foliage of the arrow-root some seasons, sometimes destroying whole fields of it.

Grape-vine Flea-beetle. (*Graptodera chalybea* (Illig.). Figure 162.

Of the Flea-beetles, the only one identified in our collection is the steel-blue Grape-vine Flea-beetle (*Haltica* (or *Graptodera*) *chalybea* Illig), fig. 159, which feeds on the leaves of the grapevine and woodbine, but Mr. Bishop reports other species.

157

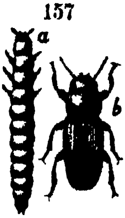

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Figure 157.—Meal worm (*Tenebrio molitor*); *b*, imago; *a*, its larva, nat. size. From Webster's International Dictionary, after Chittenden. Figure 162.—Grape-vine Flea-beetle; *a*, imago, enlarged; *b*, larva, ×4; *c*, earth-coated pupa-case from the ground; *d*, part of a leaf, as eaten by the larvæ; after Riley.

Strawberry Flea-beetle. (*Haltica ignita* Illig.) Figure 163.

According to the notes furnished by Mr. Geo. A. Bishop, this species is injurious to the strawberry and other plants in Bermuda. It varies in color from bright golden tints to brown and dull green.

In the United States the beetle feeds on the young leaves of grapes, woodbine, kalmia, young peach leaves, etc. The larva feeds on evening primrose, and on young leaves and the buds of grapevines.

Tobacco Flea-beetle. (*Epitrix parvula* (Fab.) Figures 164, 164*a*.

This small species is mentioned in the notes of Mr. Geo. A. Bishop as injurious to tobacco. In the United States it often does much damage to tobacco. It feeds also, as imago, on egg-plant, tomato, Jamestown-weed (*Datura*), and nightshades.

This beetle is minute; length about 1.5^{mm}, or about $\frac{1}{16}$ inch; color light brown with a darker brown band across the elytra. The larva is slender, white, with a yellow head and brown jaws; length 3.5^{mm}. It feeds on the roots of Jamestown-weed and other allied plants, and sometimes attacks common potatoes, causing them to have a rough or pimply surface. The pupa is formed just under the earth about the roots of the plants on which the larvæ feed.

163 164a 164

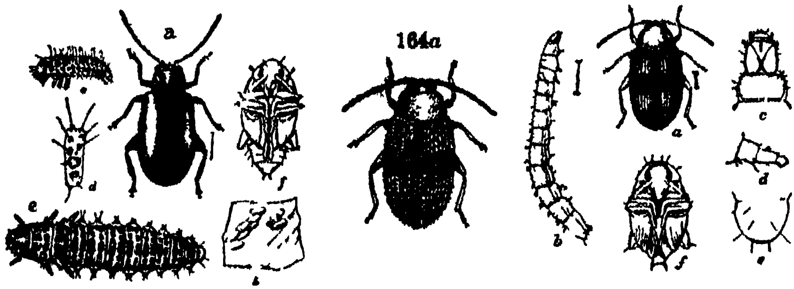

Figure 163.—Strawberry Flea-beetle (*Haltica ignita*), *a*, imago, ×4½; *b*, eggs, nat. size; *c*, larva, *d*, segment of larva, much enlarged, *e*, larva, dorsal view, enlarged, *f*, pupa, ×4. Figure 164.—Tobacco Flea beetle (*Epitrix parvula*); *a*, imago, ×10; *b*, larva, ×8; *c*, head of larva; *d*, posterior leg, *e*, anal segment, *f*, pupa Figure 164*a*.—The same; imago, more enlarged; after Chittenden

Cerambycids; Long-horned Beetles; Capricorn Beetles; Long-horned Wood-borers; Girdlers, etc.

Several undetermined species were obtained. The most interesting is a plain yellowish brown or chestnut-colored species, with a long, rather slender, cylindrical body, $12–18^{mm}$ long. It resembles an American species of twig-pruners (*Elaphidon*).

Scarabæids; Lamellicorn Beetles; Tumble-dungs; Dung-beetles; Chafers; May-bugs, etc.

Several undetermined species of this family were obtained. The most common of the larger forms is the "Hard-back," which was perhaps an indigenous species. See p. 784.

Hard-back. (*Ligyrus gibbosus* Dej. = *L. juvencus* (Oliv.) Burm.) Figure 168*a*.

J. M. Jones, 1876, states that this is the "most common beetle on the islands." It was also recorded by Heilprin (Berm. Is., p. 92) as

identified by Dr. Horn. Specimens have been received by me from several correspondents. Common in the southern United States.

It is said to be very injurious to sweet potatoes by tunnelling both in the stalks and tubers. It also attacks various other crops, such as the Irish potato, carrots, celery, beets, corn, sunflower, etc., by boring in the roots. The larva feeds both on manure and on the roots of grasses and other plants.* The color of the mature beetle is dark chestnut, chocolate-brown or black; paler when recently emerged. The prothorax is thickly, finely punctate, and the elytra have coarsely punctate grooves, unequal in size. It comes freely to lights and flies very erratically. Length 15–17^{mm}.

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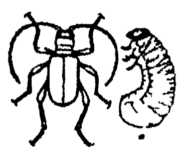
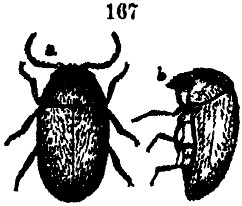


165*a*

165*b*

165

167



166*a*

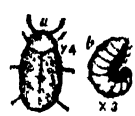


Figure 165.—Hard-back, ×1¾, from a photograph. by A. H. V. Figures 165*a*, 165*b*.—Sugar-cane Borer, Corn Borer (*Ligyrus rugiceps*), nat size and enlarged. Figure 166.—*Ptinus fur* and larva, enlarged. Figure 166*a*.—Bread-beetle (*Sitodrepa panicea*); *a*, imago, ×4; *b*, larva, ×8. Figure 167.—Cigarette Beetle (*Lasioderma serricorne*); × 6½; *a*, dorsal; *b*, profile view. From Webster's International Dictionary; after Chittenden; 166 after Packard's Guide.

A closely allied, very injurious species (*L. rugiceps*), figs. 165*a*, 165*b*, tunnels in the base of the sugar-cane stalks in the West Indies, and will, perhaps, be found here in corn, which it often attacks in the same manner.

Hard-Back. (*Ligyrus tumulosus* Burm.) Figure 165.

This species was recorded in 1889 by Professor Heilprin, on the authority of Dr. G. H. Horn, (Bermuda Islands, p. 92.)

* L. Mowbray, who sent the adult larva in December, says that it damages arrowroot and potatoes.

The specimen figured (fig. 165) has a dull brownish black surface; clypeus broadly rounded and not bidentate in front; head scarcely sculptured; tibiæ of fore legs with three short, not very stout, denticles and a spur; prothorax not very convex. Another specimen, probably the male, has a black and very glossy surface, with the same sculpture; clypeus bidentate in front; head rougher; fore legs stouter, with broader tibiæ, bearing 3 strong denticles and a sharp spur. October, L. Mowbray. Identified by Mr. Schwarz.

This species seems to have nearly the same habits as *L. gibbosus*, from which it is not distinguished by the inhabitants.

Psammodius, sp., t. Schwarz.

A small black scarabæid occurs, resembling the "Hard-back" in form, and with the anterior tibiæ flat and three-toothed. Elytra strongly sulcate; prothorax strongly convex, slightly glossy, very minutely punctate. Length 4^{mm}. Oct., L. Mowbray.

Dung-beetles. (*Aphodius*, etc.)

Several species of these beetles occur; among them, *Aphodius ruricola* Melsh. and *A. fimetarius* (L.) Illig. The latter is a small beetle, easily recognized by its bright red elytra and black head and thorax. It is also very common in New England in early spring.

Hide-beetles; Skin-beetles. (*Trox scaber* L. and *T. suberosus* Fab.) Plate xcix; figures 11, 12.

Both of these are recorded by J. M. Jones, 1876. They feed on dead animal substances of various kinds, including hides, and are widely distributed in North America. The first is brownish black with clearly black ribs and tubercles; length 7^{mm}; the second is dull dark brown, with black tubercles, and brownish yellow specks; length 15^{mm}.

Ptinidæ. Spider-beetles. (*Ptinus fur* L.) Figure 166. The larva of this small beetle is often destructive to dried animal substances, such as furs and skins, woolens, museum specimens, books, etc.; it sometimes feeds, also, on flour, cotton seed, red pepper, etc. It is widely diffused in most countries. The color of the beetle is reddish brown; the elytra are crossed by four white bars; the long legs and antennæ give it a spider-like appearance. An allied plain brown species (*P. brunneus*), having nearly the same habits, is also likely to occur, but was not seen by us.

Cigarette-beetle; Tobacco-beetle. (*Lasioderma serricorne.*) Figure 167.

This small Ptinid beetle sometimes occurs in tobacco stores, but may not be fully naturalized here. In the United States and other countries it often does great damage to cigars and to tobacco in all other forms in warehouses. It also sometimes feeds on dried fish, figs, rice, yeast-cakes, ginger, rhubarb root, red pepper, ergot, herbarium specimens, silk fabrics, etc.

Drug-store Beetle; Bread-beetle. (*Sitodrepa panicea* L.) Figure 166*a*.

This little beetle is nearly cylindrical and about 2.5^{mm} long, plain light brown in color, and with striated elytra. Its larva is a great pest in most countries, for it destroys all sorts of drugs of vegetable and animal origin, as well as dried bread, ship biscuit, flour, meal, beans, peas, coffee, chocolate, nuts, and all sorts of seeds. It is partial to dog-bread. Among drugs and condiments, it is very fond of red pepper, black pepper, ginger, rhubarb, orris root, wormwood, anise, etc.; nor does it object to aconite, belladonna, and cantharides. The larva has powerful jaws with which it can gnaw tunnels through the hardest dried roots, cloth, leather, etc. It is said that it sometimes even penetrates tinfoil and sheet lead, if in its way.

Cleridæ. This family is represented by at least the Red-legged Bacon- or Ham beetle (*Necrobia rufipes* DeGeer), fig. 168, whose larva often does great damage to hams and bacon. It also feeds on various other dry animal products. The beetle is dull bluish, with red legs; the larva is whitish, mottled with gray. It is found in nearly all warm countries.

Lampyridæ; Fire-flies; Fire-beetles; Lightning-bugs; Glow-worms.

Although no representatives of this family were in our collections, it seems desirable to call attention to the efforts that have been made to introduce at least one species, whether successfully or not we do not know. It probably would not have appeared so early in the spring as the period of our visits.

American Fire-fly or *Lightning-bug.* (? *Photuris Pennsylvanica* (DeG.) Lec.) Figures 169, 170.

Mr. J. M. Jones (Visitor's Guide, 1876) states that Gov. Lefroy had recently introduced the American Fire-fly, presumably *Photinus pyralis* (L.), or *P. Pennsylvanica* (figs. 169, 170), but he did not know whether it had then become naturalized.

One of the more common American species (*P. pyralis*), Fig. 169 is blackish-brown with a narrow, pale yellowish line along each margin of the elytra; the thorax has a yellow margin, and a reddish spot in the middle, centered with a black spot. It is about half an inch long. The larvæ are also luminous in this and some other species, and in that state they resemble the true Glow-worms.

Larger Fire-beetle.—Mr. Hurdis (Rough Notes, p. 329) records

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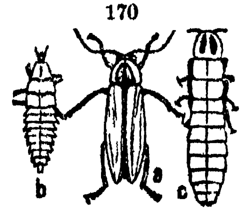

Figure 169.—Fire-fly (*Photinus pyralis*); *c*, imago, natural size; *a*, larva; *f*, *e*, *d*, head, under side of segment, and leg of same; *b*, pupa in its earth-covered case; after Riley. Figure 170.—Fire-fly (*Photuris Pennsylvanica*); *a*, imago; *b*, larva of *Photinus*; *c*, Glow-worm, adult wingless female of a foreign species; after Packard.

seeing a large, bright, undetermined fire-fly, Aug. 14, 1850. I am not aware that it has been subsequently seen or determined. The common American Fire-fly rests on the under side of the leaves of low shrubs, or on weeds and grass, in the day time. It would undoubtedly be easy to introduce several of our southern species.*

Buprestidæ; Shining Wood-borers; Flat-headed Borers. (*Buprestis*, etc.)

The best known example is a North American species (*Ancylocheira decora* (Fabr.) Dej. = *Buprestis decora* Oliv.) recorded by Jones in 1876.

Chrysobothris impressa (p. 786, fig. 155, *a*) has been determined for me by Mr. S. Henshaw from Mr. T. G. Gosling's collection.

Elaters; Snapping-beetles; Skipping-beetles; Click-beetles; Wire-worms.

This family is represented by several undetermined species. The most common is a species of *Agriotes*. Perhaps it is *A. mancus*, whose larva is a Wire-worm destructive to wheat and grass in the United States.

* For descriptions of the N. American species of this family, see Leconte, Synopsis Lampyridæ, Trans. Amer. Entom. Soc., ix, pp. 15–72, 1881.

Monocrepidius lividus (Dej., t. Schwarz.) Plate xcix ; figure 13.

This Elater, sent by Miss Hayward in October, has the outer posterior angles of the prothorax prolonged in a sharp spine ; elytra strongly sulcate ; color blackish brown. Length, 12^{mm}.

Dermestids; Larder Beetles ; Carpet Beetles, etc.

Among the numerous introduced species injurious to stored provisions are several beetles of the family Dermestidæ. Of these we can record the following : Larder-beetle (*Dermestes lardarius*), fig. 171, destructive to all dry animal substances; Carpet-beetle or Buffalo-

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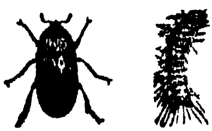

171*a*

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Figure 171.—Larder-beetle (*Dermestes lardarius*), × 1½ ; and larva, nat. size. Figure 171*a*.—Carpet-beetle, with larva and pupa; after Riley, × 3. Figure 172.—Museum-beetle (*A. verbasci*) ; *a*, larva ; *b*, pupa ; *c*, imago ; × 6. All from Webster's International Dictionary.

bug (*Anthrenus scrophulariæ*), fig. 171*a*, whose larva is destructive to woolens, but the imago is common on flowers in spring; Museum-beetle (*A. verbasci*=*A. varius*), fig. 172, whose larva infests not

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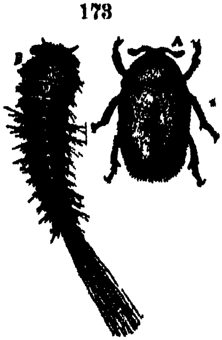

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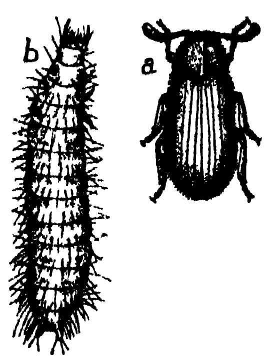

168*a*

Figure 173.—Tapestry-beetle, × 3½ ; *a*, imago ; *b*, larva ; after Chittenden. Figure 168.—Ham-beetle (*Necrobia rufipes*) ; *a*, imago ; × 4 ; *b*, larva, × 6. From Webster's International Dictionary ; after Howard and Marlatt. Figure 168*a*.—Hard-back (*Ligyrus gibbosus*), × 1½ ; after Chittenden.

only bird skins and dried insects, but also all sorts of dried animal substances and some dry vegetable products; Black Carpet-beetle or

Tapestry-beetle (*Attagenus piceus* Ol.), fig. 173, often destructive to carpets and rugs. The last named feeds also on all kinds of dried animal substances, even including leather, wool, silk bolting cloth, feathers, etc., and not infrequently attacks flour, meal, grain and various seeds and drugs, including red pepper.

Probably *Trogoderma tarsale* Melsh., another related, common, omnivorous beetle also occurs, though we secured no specimens. Like the last, it eats all sorts of dried animal substances and occasionally feeds on meal, grain, corn, peanut cake, oil seeds, etc.

Histerids.—One species of this family was obtained.

Epuræa luteola Ev. (t. Schwarz), family *Nitidulidæ*, a small cosmotropical species, found also in Florida and Texas, was sent by L. Mowbray.

Coccinellids; Lady-bugs; Aphis-wolves; Squash-beetle.

Larvæ of one species were observed devouring aphids.*

Dr. Fr. Dahl (Plankton Exped., i, pt. 1, p. 108) also records a species of *Coccinella.*

Staphylinids; Rove-beetles.

Several species of Rove-beetles were found, but are mostly undetermined. One of the most abundant under dead fishes on the shores was a very small black species.

The largest is *Creophilus villosus* Kirby, an American species, about .5 to .75 of an inch long, glossy black, with patches of fine gray hairs, a band of which crosses the elytra; another crosses the second and third abdominal segments.

Dytiscids; Water-beetles.

This family is represented by at least one North American species (*Thermonectes ornaticollis* Aubé = *T. irroratus* Melsh., t. Leo., Cat.). The thorax is fulvous, with two transverse blue lines. Length, 12^{mm}. Its aquatic carnivorous larvæ devour the larvæ of mosquitoes and other insects. Other related species, which are numerous in the United States, could easily be introduced and would be very useful.

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* It would, doubtless, be very easy and very advantageous to introduce many additional species of Lady-bugs from the United States and West Indies to destroy the numerous Aphids and Scale-Insects found here. This has been done in California, with admirable results, as in the case of *Vedalia cardinalis*, introduced from Australia to destroy *Icerya Purchasi*. See p. 804.

Carabids; Ground-beetles.

Several species of this group were found under stones, etc., but they are mostly undetermined. J. M. Jones recorded under *Platynus, Anchomenus cincticollis* (Say) Lec. and *Agonum punctiforme* (Say) Lec., both of which are black species, found commonly in the eastern United States.

Mr. Mowbray sent in October a species of *Anchomenus* which Mr. Schwarz thinks may be undescribed. It is 9^{mm} long, glossy bluish black; elytra strongly sulcate; prothorax smooth, shining; legs dark brown; antennæ brown, long and slender.

Striped Ground-beetle (*Agonoderus lineola* (Fab.) Lec.) Plate xcix; figure 14.

A small, light rufous-yellow or brownish-yellow beetle with two rather wide, blackish dorsal stripes on the elytra, not reaching their tips, but extending forward on the hind part of the prothorax; a narrow and less distinct line of black along the outer margin; prothorax with a pair of small, round, black spots. Length, 6^{mm}

It is very common here, just as in the United States.

Cicindelids; Tiger-beetles.

Cicindela tortuosa Dej. This North American species, which is said by Jones, 1876, to be very common in summer, is the only Tiger-beetle recorded.

In addition to the species enumerated above, the following North American Coleoptera were recorded by J. M. Jones, in 1876:

Pristonychus complanatus,* a ground beetle, common and often gregarious under stones; *Hymenorus obscurus*=*Allecula obscura* Say; rare. The latter is a species of the family *Cistellidæ*.†

Dr. Fr. Dahl (Plankton Exped, i, pt. 1, p. 108, 1892) has recorded undetermined species of *Olibrus*, of the family Phalacridæ, and *Exophthalmus* Latr. The latter is a West Indian genus.

A more careful search than we were able to make, and especially in the summer, would doubtless result in the discovery of scores of additional species.

* This was also obtained by us, and it was sent in October by Mr. Mowbray. Surface of body above and below, elytra, and legs, glossy bluish black; thorax nearly smooth, but with three shallow, broad depressions, convergent backward; edges acute, thin, slightly upturned; elytra with nine deep sulci, those on the dorsal side wider than the intervals, becoming much narrower, with wider ridges on the sides; antennæ long, dark brown; posterior femora thickened, smooth. Length, 18^{mm}.

† According to Riley, it lives in the nests of ants

j.—Hemiptera. (Bugs; Scale-insects; Plant-lice; Thrips, etc.)

The *Cicada Bermudiana* (p. 736) was the only insect of this order mentioned by the early writers. It is probable, however, that various other less conspicuous native species existed. But as most of the known injurious species feed on introduced plants and are common North American or European species, it is pretty certain that they have been mostly introduced with the plants. However, those plants that have been introduced only by means of seeds have thus often escaped the aphids and scale-insects that infest them in their native countries. A number of species in our collection are still undetermined. See Addenda.

The Bed-bug (*Acanthia*, or *Cimex, lectularius*), and the various species of parasites that infest man and the domestic animals, were doubtless introduced from Europe by the earliest settlers.

Pentatomids; Leaf-bugs.—Several members of this family occur, but only a few have been determined.* A green Leaf-bug (*Nezara viridula* (L.), which lives on the leaves of various trees, is light green, with the membrane and wings transparent; three white spots on the scutellum; abdomen keeled; venter yellowish. It is widely distributed in warm countries: West Indies; South America; Africa; South Europe; southern United States; India; East Indies, etc. See Howard, Ins. Book, pl. xxx, fig. 32.

It is probably the same as *Rhaphigaster prasinus* (L.) Dallas, Catal. Hem. Brit. Mus., i, p. 274, recorded by J. M. Jones, 1876. He also recorded another related species, as *R. cydnus*.

Cedar-berry Bug. (*Banasa euchlora* Stål.) Plate xcviii; fig. 1.—This species was first recorded by J. M. Jones.

A specimen, taken at St. David's I. in October, was sent to me by Miss V. Hayward, with the information that it feeds on cedar berries in autumn, when it becomes common, and that when living it is very malodorous. The body and front wings are bright light green; hind wings pale heliotrope-purple. Expanse, 18^{mm}.

* The larva of a large Leaf-bug was sent by Mr. L. Mowbray, in November. Body short, broad, depressed; length, 11^{mm}; breadth, 9.5^{mm}. Scutellum broader than long; thorax closely and rather coarsely punctate, dark brown, the sutures bordered with light chestnut brown; front of head brownish yellow; abdomen, above, dark brown centrally, yellowish laterally, and margined with orange; a narrow black line along the thin edges of the segments and running inward so as to make a bracket-shaped mark on each segment; legs mostly black; wing-pads dark brown, with lighter edges. Mr. Otto Heidemann, who has examined the specimen, thinks it is probably a *Nezara*.

Tomato Leaf-bug. (*Mormidia lugens* (Fab.) Stål.) Howard, Insect Book, pl. xxxi, figs. 3, 4.

Mr. Geo. A. Bishop, in a recent letter, states that this insect is injurious to the tomato-plant and beans. Common in U. States, Mexico, and W. Indies.

Capsids. The small Leaf-bug figured (*Lygus*, pl. xcix, fig. 17, *d*) is pale green with a greenish yellow head, and an obscure, oblique brownish spot near the base of the fore wings, and some ill-defined spots of the same at the tip. Length, 5^{mm}.

Orthops, sp., t Heidemann.

Mr. Geo. A. Bishop writes that this bug does considerable damage to peaches by puncturing the surface with its proboscis.

Tarnished Plant-bug. (*Lygus pratensis* (L.) var.=*L. lineolaris* P.-Beauv.; Saunders, Ins. Injur. to Fruit, p. 147, fig. 155. Figure 174.

This species was sent by Mr. Mowbray in October. In the United States it is injurious to strawberries, fruit trees, etc. Head, between eyes, yellowish, with three narrow black lines convergent backward; prothorax dull brown, varied with blackish and yellow and narrowly edged with yellow; about six alternating, black and yellow, ill-defined, small, divergent spots; scutellum acute, larger than broad, with dark brown and chestnut or yellowish brown convergent markings; thickened part of front wings dark brown varied with chestnut, and terminated by a yellow spot; membranous part dusky gray; abdomen blackish below, with a lunate yellow spot on each side; legs chestnut, banded with black; antennæ black. Length, 4.75^{mm}. Identified by Mr. O. Heidemann.

Trigonotylus ruficornis (Fall.) Fieber, Europ. Hemip., 243; Uhler, in Bull. U. S. Geol. and Geog. Survey Terr., iii, No. 2, p. 413.

A small, slender bug, 5^{mm} long. Thorax and abdomen, above and below, light greenish, with a geminate, dusky, median dorsal line on the thorax; fore wings yellowish at base, membrane purplish white; legs pale drab; antennæ long, pale lilac. Identified by Mr. O. Heidemann. October, L. Mowbray. Europe and North America. Denver, Col., Uhler.

The family *Berytidæ* (Stilt-bugs) is represented by a single slender-legged species (*Corizus hyalinus*), recorded by Jones, 1876. In the United States it ranges westward at least as far as Colorado.

Cydnidæ; Ground-bugs.—This family of burrowing bugs is represented by at least one North American species (*Pangæus bilineatus* Say), determined by Uhler, which burrows under rubbish at high-tide mark on the shores. It is fully described by Uhler in Bulletin Hayden's U. S. Geolog. and Geog. Survey, vol. iii, p. 388, 1877.

A specimen of this species (fig. 175), taken early in September, was sent by Miss Victoria Hayward. It is glossy black, except the tarsi and antennæ, which are dull buff. The head is sparsely covered with short black hairs; prothorax and scutellum sparsely punctate; ocelli ruby-red. Length, 6.5^{mm}. See Howard, Ins. Book, pl xxx, fig. 2. Our figured specimen bears a parasitic mite. See p. 842.

The larva of another species was sent by L. Mowbray in October. Body short, broadly ovate, head and thorax wide, together longer than abdomen, smooth, dark brown; rudiments of wings the same; abdomen pale buff, narrowly margined with dark brown, and with a median dorsal dark brown patch, consisting of a spot on each of five or six segments. Mr. O Heidemann refers it to the genus *Æthus* Dall. (Uhler, op. cit., p. 378, 1877.) He also identifies *Pamera bilobata* (Say), from the same lot. It is a slender predaceous bug; body dark brown; fore wings with 2 black cross-bars; length 5^{mm}.

In addition to the Hemiptera enumerated above, J M. Jones, 1876, recorded the following: *Aulacostethus simulans.*

Dr. Fr. Dahl (Plankton Exped., i, part 1, p. 109) records also an undetermined species of *Nabis*, and one of *Capsus*.

Jassidæ; Leaf hoppers.—One species of this large family has been recorded both by Jones and Uhler: *Cœlidia olitoria*=*Jassus olitoria* Say, (Ent., ii, p. 385.) It is native of the United States.

In this species the head is yellow; hypostome with a red vitta on each side; thorax blackish blue, edged with dull rufous; wing-covers bronzy brown with fuscous veins; body black below; anterior legs pale yellow; posterior pair with the tibia and femora bluish black, the latter yellowish distally, their tarsi yellowish. Length, about .25 inch (6^{mm}).

Leaf-hopper. (*Cœlidea*, or *Jassus*, *flaviceps* (Stål.)

Head broad, light yellow; prothorax punctate, dark rufous brown; scutellum varied with dark brown and chestnut; wings lustrous, dark bronzy brown, becoming orange-brown at the margins and apex; veins black; legs paler, chestnut-brown, with a dark line on the outer side of the femora and front side of the long posterior

tibiæ ; length, 9^{mm}. October, L. Mowbray. Identified by Mr. O. Heidemann.

Leaf-hopper. (*Cicudula*, sp., t. O. Heidemann.)

Head, body, and legs light green, darker on abdomen, which is crossed by narrow, pale yellowish green sutural bands ; wings whitish, faintly tinged with yellow or pale lilac ; eyes blackish. Length, 2.4^{mm}; to tips of folded wings, 3.6^{mm}. Several sent by L. Mowbray in October.

Fulgoridæ.—The Lantern-fly family is represented by a small species: *Pœciloptera*, or *Ormenis*, *pruinosa* Say, the "frosted hopper," recorded by Jones, 1876.

The larva is white or pale green, with dark feet. It is more or less covered with a white thread-like secretion, forming a tuft at the

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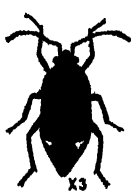

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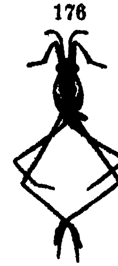

Figure 174.—Tarnished Leaf-bug, × 8⅛ ; after Saunders. Figure 175.—Black Ground-bug (*Pangæus bilineatus*) ; × 4⅛. Figure 176.—Ocean-bug (*Halobates*, sp.), nat. size ; from Webster's International Dictionary.

end of the body and easily detached. They feed in colonies on the under side of leaves and twigs of various plants. The adults vary in color, some being whitish, others bluish gray.

The general color of recent specimens is purplish brown, with more or less numerous grayish white, minute scales on the back and anterior part of fore wings ; prothorax black ; eyes edged with orange ; front margin of fore wings orange-brown; length, 7^{mm}. Common in August, Miss V. Hayward, who forwarded specimens for the figures. Plate xcix ; figure 17, *a*, *b*, *c*. See Howard, Ins. Book, pl. xxvii, fig. 26.

Ocean bugs. (*Halobates*, fig. 176.) One species (*H. Wüllerstorffi* Frauenf.) of this remarkable family has been taken at sea, off

Bermuda, and probably it will occasionally be found cast ashore in masses of gulf-weed, after storms. It lives on the surface of the sea, quickly moving about by means of its long legs, much like the "skating-bugs" on fresh water. (See White, Voy. Chall., vii, p. 40, pl. i, fig. 1.)

Aphids; Plant lice.

Several species of aphids were obtained, but some have not yet been determined. One, which was found common on the leaves of the lemon and orange trees, is apparently *Neotophora*, or *Siphonostoma, citrifolii*, fig. 177. Common on the orange in this country also, and capable of doing much injury. The body, both of the apterous and winged forms, is black or dark brown.

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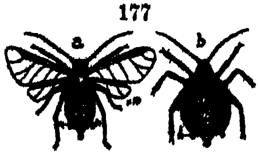

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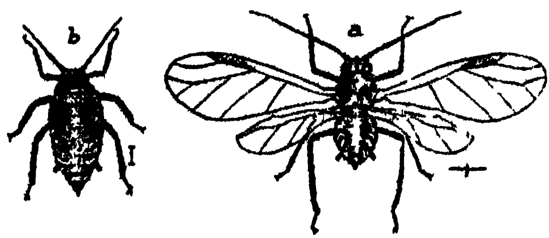


Figure 177.—Orange Aphis (*Neotophora citrifolii*), much enlarged; *a*, winged form, *b*, wingless form; *s*, *s'*, abdominal tubercles. Figure 178.—Cabbage Aphis (*Aphis brassicæ*); *a*, winged male; *b*, oviparous female, both much enlarged; after Weed.

Cabbage Plant-louse; Cabbage Aphis. (*Aphis brassicæ* L.) Figure 178.

According to the notes of Mr. Geo. A. Bishop, this species is often injurious to the cauliflower. Doubtless it occurs also on cabbage.

The winged males have a small body; thorax brown or blackish; abdomen pale greenish brown, with transverse rows of black spots; legs mostly black.

The oviparous females are pale green with three rows of indistinct blackish spots on the abdomen, and two rows on the thorax; legs and antennæ dull brown.

Coccids; Scale-insects; Mealy-bugs; Bark-lice.

Numerous species of these destructive insects are particularly liable to be introduced attached to the bark and leaves of growing

plants, or on fruit, or even on cuttings of vines and trees. It is well known that some of these have been particularly destructive to the orange and lemon trees in Bermuda (see pp. 526, 685), and doubtless also to other fruit trees, as the peach, fig, pomegranate, avocado pear, etc.*

The vast economic importance of the Scale-insects, as affecting

* The killing of these very destructive insect pests is absolutely necessary in cultivating fruit trees successfully, according to modern methods All reputable dealers in nursery stock in the United States now give written guarantees that all stock sold is free from such insects, or that it has been properly fumigated. Local laws should prohibit the importation of all nursery stock without such a certificate, or else should provide for careful inspection before entry.

The use of hydrocyanic-acid gas for disinfecting nursery stock, as well as growing trees of large size, is now extensively employed in the United States, with excellent results. It is equally applicable for killing all kinds of insects in conservatories, unoccupied dwellings, storehouses, etc.

The proportion of potassium cyanide required for very thorough fumigation is 1 oz. av. for every 100 cubic feet of space. For every ounce of cyanide 1 fluid oz. of sulphuric acid is required; it is to be diluted with 2 or 3 parts of water, before using. The cyanide, done up in thin paper packages, each of the proper quantity for a tent or room, is dropped into the dilute acid contained in suitable porcelain or stone-ware receptacles (earthenware wash-bowls or pitchers do very well) large enough to avoid overflow by the foaming and then the doors to rooms or tents are quickly closed, and kept closed for an hour or more, if possible, though half an hour is often effectual. Rooms should be thoroughly aired for several hours before being again occupied, for the gas is very deadly. All windows and cracks should be tightly closed before fumigating. A small wire or string may be used to suspend the packages of cyanide over the acid, so that these can be dropped into it from outside the closed doors or windows, by releasing or cutting the strings, thus avoiding the fumes. The receptacles for the acid should be placed on thick papers, boards, or some other material to protect floors from the spatterings of the acid, when used in dwellings. The tents used for covering fruit trees for fumigation can be made of thin drilling rendered nearly air-tight by some suitable flexible varnish, such as boiled linseed oil, or by a mixture of paraffine and naphtha, used as a varnish. Small tents for young trees can be cheaply supported by a light frame made of one or more barrel hoops which can be made to fold up if desirable; for small trees some have used light octagonal frames covered with strong paper, and having a conical hood. If enclosures are not very tight, more cyanide and acid must be used.

Kerosene emulsion sprayed over the trees, or even applied to the trunk and branches with a brush, is also very effective. One pound of soap is dissolved in 1 gallon of hot water; this after cooling to be mixed with 2 gallons of kerosene; the whole to be churned together, by means of a syringe or force pump, till it forms a creamy emulsion. This is diluted with 8 to 10 parts of water when used for scales. This emulsion is also effectual against all other insects on trees when more diluted, even with 12 to 15 parts of water.

the cultivation of fruit in every country, has recently led to very numerous scientific investigations and experiments and to an extensive literature, especially in the United States. Effectual methods of several kinds have thus been discovered for destroying them on infected trees and for preventing their spreading. But constant watchfulness, promptness, and perseverance will always be necessary on the part of those who have the care of fruit orchards, for these insects increase with marvelous rapidity, even in one season.

A very useful report on Scale-insects, by Professor J. H. Comstock, is in the Annual Report of the Entomologist of the United States Department of Agriculture for 1880. In this report many of the species affecting fruit trees in the United States are described and figured. Numerous later reports have been published by the same department, and also by the Experiment Stations of various States The species found in Bermuda, so far as known, are all found also in the United States, and therefore the reports referred to are equally applicable here, especially those relating to the orange-scales.

We collected a number of species, but some have not yet been determined by the specialists to whom they were sent.* One of the most common, *Icerya Purchasi*, is very injurious to the orange, lemon, galba, pomegranate, tamarisk, roses, hibiscus, etc.

We could not learn that the very pernicious San José Scale (*Aspidiotus perniciosus*), fig. 186*b*, p. 811, has yet been found here. It would be likely to infest especially the loquat tree, if introduced, but it feeds on many kinds of trees.†

Four or five species, at least, were found abundant on the orange and lemon trees. The most common and destructive are the Purple Scale, figs. 182–182*b*, and the Fluted Scale (*Icerya*). In a recent letter to the writer, Mr. Geo. A. Bishop, superintendent of the Public Garden, reports several additional species, mentioned below.

Cottony Cushion-scale; Fluted Scale. (*Icerya Purchasi* Maskell.)

FIGURE 183, p. 810

This scale, which was found by us common on the orange and several other trees in April, had already been recognized as a

* We collected or observed Scale-insects on the following trees and shrubs: orange, lemon, citron, loquat, fig, avocado pear, pomegranate, oleander, olive, hibiscus, fiddle-wood, frangipani, wild jasmine, grape, galba, cycad, etc.

† According to recent investigations by Mr. C. L. Marlatt, this species is native of North China. Bull. 37, new ser., Divis. Entom., U. S. Dep. Agric., p 65, 1902. See also Bull. No. 3.

destructive insect in Bermuda. It is easily recognized, when adult, by the peculiar form and fluting of its scale or egg-case, which is pale yellow and filled with a white cottony secretion. The body of the insect, which is nearly concealed by the egg-sac, is orange-red, its back being partly covered with a whitish powder ; antennæ and legs black; eggs pale red, 200 to 400 in each egg-sac. Immature females are covered with tufts or filaments of a cottony secretion. It attacks both the leaves and branches, increasing very rapidly, and often kills the trees. This insect was introduced into California* about 1868, and into New Zealand, South Africa, and Florida soon after. Before that time it had attracted little attention. In South Africa it quickly destroyed great numbers of orange trees, even those of the largest size, and spread to a great variety of other trees and shrubs. It was formerly one of the most destructive species in California. It is not known when it first arrived in Bermuda, but probably not till after 1876. The Australian Lady-bug (*Vedalia cardinalis*, see fig. 183*a*) was imported by experts of the U. States Agricultural Department into California to destroy this scale, and has proved very beneficial there, the damage from this species being very little at present. The Vedalia has also been successfully introduced into India, Egypt, Portugal, New Zealand, Hawaiian Islands, and other countries for the same purpose. It should be introduced into Bermuda, from the United States, which could easily be done.†

183*a*

* It is said to have been brought to California from Australia, but some suppose that it was originally native of the Pacific Islands. That its natural enemies (like the Vedalia) live in Australia is evidence that it was native there, but not conclusive.

† Several other species of Australian Coccinellids were also successfully introduced into California in 1892 by the entomologists of the U. States Department of Agriculture. Among the most important of these is *Rhizobius ventralis* Er., which feeds voraciously on *Lecanium oleæ* and other species of *Lecanium* and *Eriococcus*. It survives the winter well and increases rapidly, so that it is of great value for destroying these scales.

Rhizobius debilis and *R. satellus*, though successfully introduced, did not increase so rapidly as the former. *R. debilis* feeds on the San José Scale and related species, as well as on *Lecanium*. *Orcus Australasiæ* and *O. chalybeus* were both successfully introduced and increased rapidly in some localities. The former feeds on the San José Scale and related species; the latter on *Lecanium oleæ*, etc. Very likely some of these could easily be introduced into Bermuda.

Mealy-bug. (*? Dactylopius destructor* Coms., Ann. Rep. Agric. Dep., Ent., for 1880, p. 342, pl. xi, fig. 3; pl. xxii, fig. 2; Man. Entom., p. 167, fig. 205.) Figure 179.

A species of Mealy-bug, which was found on various shrubs and trees, apparently belongs to this species, but it was not carefully studied and the specimens were not preserved. Possibly it may have been the common Mealy-bug of the greenhouses (*D. adonidum* (L.) Sig.), in part. The former attacks various trees and shrubs in Florida and is very injurious to the orange trees. It is also very partial to the coffee-tree.

Orange Mealy-bug. (*Dactylopius citri* Bois.)

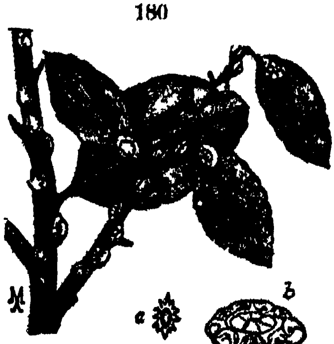
Mr. Geo. A. Bishop reports that a Mealy-bug, identified as this species, occurs on the orange and other citrus trees in Bermuda, and also on various garden vegetables, especially potatoes.

Orthezia insignis Douglas, Entom. Monthly Mag., p. 169, Jan., 1888.

PLATE XCVIII; FIGURE 16.

This elegant species was sent to me living, by Miss Hayward, early in September. With it were many minute, yellowish white, ovate mites, which seemed to be parasitic upon it. See ch. 38, *b*.

180



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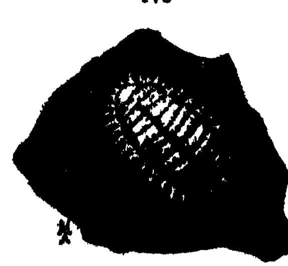


Figure 180. — *Ceroplastes Floridensis*, on orange tree, nat. size; *b*, enlarged. Figure 181.—Olive-scale or Black-scale (*Lecanium oleæ*); *a*, natural size, and *b*, enlarged. Figure 179.—Destructive Mealy-bug (*Dactylopius destructor*), × 5; after Comstock.

The body is dark brown, strongly grooved transversely; it bears a central double row and a marginal rosette of pure white scale-like secretions; posteriorly these become much elongated in the adults

and unite with the sheath-like or tubular secretion of the under side to form a continuous egg-sac, truncate and closed posteriorly, grooved on the upper side ; legs and antennæ dark brown or blackish. Length, 3mm.

It occurs in the West Indies and South America, and in greenhouses in the United States and Europe, feeding on *Coleus* and various other herbaceous plants.

Broad Scale. (*Lecanium hesperidum* (L.) Figures 181*a*; 184, *a*.

This species was taken by us in 1901 on a species of *Hibiscus*, used as hedges. Mr. Geo. A. Bishop states that it is not only injurious to hibiscus, but infests oranges and other citrus fruits, and the galba. It is liable to attack a great variety of trees, and is very widely diffused.

181*a*

181*b*

Figure 181*a*.—Broad Scale (*L. hesperidum*), on orange tree; nat. size. Figure 181*b*.—Hemisphærical Scale, on orange tree, nat. size, and *a*, enlarged. Both after Comstock.

Black Scale; Olive Scale. (*Lecanium oleæ* Bern.) Figure 181.

This scale is very injurious to the olive and orange, etc. According to the notes of Mr. Geo. A. Bishop, it also infests oleander and *Hibiscus*. It is liable to attack many other plants, as pear, apple, apricot, plum, pomegranate, palms, coffee, rose, jasmine, etc.

Hemisphærical Scale. (*Lecanium hemisphæricum* Targ.; Comstock, Ann. Rep. Ent. for 1880, p. 334, pl. viii, figs. 8, 8*a*; Man. Ent., p. 171, fig. 211=*Saissetia hemisphæricum.*) Figure 181*b*.

This large, smooth scale-insect was found by us on the leaves of the cycad (*Cycas revoluta*), oleander, hibiscus, etc. In California it has been found to attack the orange. It is also common on various greenhouse plants.

? *Lecanium nigrum* Nieter.

According to Mr. G A. Bishop this scale has been observed in Bermuda on oleander and hibiscus. It was originally described from Ceylon on coffee trees, but has since been recorded in several other tropical countries, among them Jamaica and Porto Rico, and on various plants, as Mr. Nathan Banks informs me.

? *Ceroplastes Floridensis* Com Figure 180.

A scale, which may be this species,.occurs on the avocado pear, loquat, tamarisk, etc.

Purple Scale. (*Mytilaspis citricola* Pack.; Comstock, Ann. Report Dep. of Agriculture for 1880, p. 321, pl. vii, fig. 1; xx, fig. 3; xviii, fig. 3.

FIGURES 182–182*b*, *a*, *b*, *c*, 184, *b* PLATE XCVI, FIGURES 4, 5, 6, *a*, *a*

This species, which has long been recognized as occurring in Bermuda,* appears to be at present the most abundant and most

Figure 182.—*a*, *b*, females of Purple Scale (*Mytilaspis citricola*), on twig of orange tree, *d*, free young, *c*, white males of *Chionaspis citri*; *e*, female of the latter, ×4½. Phot. by A. H. V., Aug., 1902, from life.

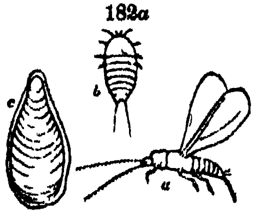
destructive species on the orange and lemon trees, which it rapidly kills. Perhaps it was the species chiefly instrumental in the former destruction of the orange trees. See pp. 526, 635.

Miss Victoria Hayward recently (Aug. 26) sent me by mail a number of branches and leaves of the orange, some of which were almost completely covered by the living adult and young scales, among and over which great numbers of the newly hatched young

* Glover, Rep. Dep Agric. for 1856, p. 119, says that it was imported into Jacksonville, Fla. in 1855 on lemons from Bermuda. Mr. Saunders (Insects Injurious to Fruit, p. 391) also states that this species is supposed to have been brought to Florida from Bermuda on lemon plants.

were still actively creeping about. She also sent an orange fruit, which is thickly covered with the same scale and has become hard and woody, with the rind black and deeply wrinkled and pitted, but it still adheres to the twig, showing very plainly the destructive effect of this scale, both on the tree and fruit. See pl. xcvi; figs. 4–6.

182a



182b

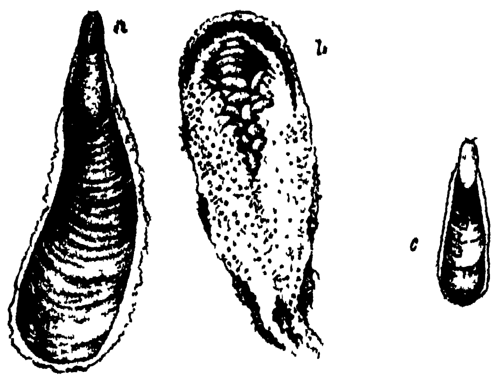


Figure 182a.—Purple Scale; *a*, winged male; *b*, active young, female; *c*, adult scale; all enlarged; after Glover. Figure 182b —Purple Scale of Orange (*Mytilaspis citricola*); much enlarged; *a*, female scale, empty; *b*, the same, under side, showing eggs, *c*, male scale; after Comstock.

These scales are mostly long-ovate, acute at one end, variable in breadth, and frequently one-sided or curved, thus in shape not unlike an elongated American oyster-shell. The color of the adult female scales is dull reddish brown or purplish brown; the smaller female scales and the male scales are similar in form, but are lighter brown.

Orange Chionaspis. (*Chionaspis citri* Comst.)

Figure 182, c. Plate XCVI, Figures 5, c; 6, c.

Associated with the preceding were considerable numbers of much smaller, white, elongated-oblong scales (fig. 182, *c*) which have a median rounded ridge or carina along their whole length. They have been determined as the males of this species by Mr. Nathan Banks. The species is widely distributed. It is said to be the most abundant and injurious species on the orange trees in Louisiana. (See Insect Life, v, p. 282.)

The females are very similar to those of *A. citricola*, but are flatter and more abruptly widened posteriorly, this expanded part

often being slightly whitened, as in fig. 182, *e*, which is unusually broad and white posteriorly.

In a letter by Mr. J. B. Heyl, published in Insect Life, vol. iv, p. 207, 1892, he states that the Scale-insects of the orange were introduced by a cargo of infected oranges from a ship in distress, that put into Bermuda in 1858 or 1859. The oranges having been sold at auction were disseminated over the islands The orange trees, which before that time were "clear of insect pests," became quickly infested. He describes this particular scale as spreading very rapidly

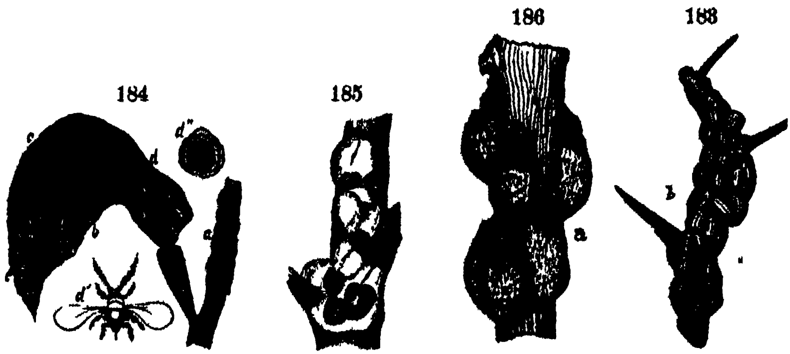


Figure 184 —*a*, Broad-scale (*Lecanium hesperidum*); *b*, Purple-scale (*Mytilaspis citricola*); *c*, Long-scale (*M. Gloveri*); *d*, Red-scale (*Aspidiotus aurantii*); *d*, male, *d'*, female; *e*, White-scale (*A. Nerii*) Figure 185.—Mealy-bug, after Harris. Figure 188.—Fluted Scale or Cottony Cushion-scale (*Icerya Purchasi*). Figure 186.—Mealy-bug (*Pulvinaria innumerabilis*), which infests grape-vines, etc. All slightly reduced, from Webster's International Dictionary; mostly after Comstock and Saunders.

and causing the trees to look as if whitewashed, and states that most of them soon died. Mr. C. V. Riley identified this scale as *Chionaspis citri*, which is still common and destructive here, but probably less so now than the Purple Scale and *Icerya*. However, it is a matter of history that long before the date given by Mr. Heyl the orange trees had suffered severely from disease, probably due to Scale-insects, and that their cultivation had consequently greatly diminished before 1836.* (See p. 685.) Probably the Purple Scale was introduced at an earlier date than the others and had been equally destructive. The *Icerya* is a much later introduction, probably subsequent to 1876.

* Bishop Berkeley, 1724, and W. F. Williams, 1848, mentioned the scarcity of oranges at these dates. According to the former they had then been scarce for 40 years, or since 1684, due, as he supposed, to cutting down the cedar forests; but Scale-insects may have been the main cause. See Errata.

? *Chaff-scale.* (*Parlatoria Pergandii* Comstock, Annual Rep. Dep. Agric. for 1880, p. 327, pl. xi, fig. 4; pl. xx, fig. 5.) Figure 185*a*.

Mr. C. V. Riley (Bulletin No. 15, U. S. Dep. Agric., Entomol. Div., 1887) states that this species was introduced into Florida from Bermuda about 1855, but perhaps he had in mind *Mytilaspis citricola*, concerning which the same statement had long before been made by Glover (see note, p. 808), for this species was not described until 1880. I do not know that it has been otherwise recorded, though it may well occur.

Aspidiotus Maskelli Cockerell ?

Mr. Geo. A. Bishop, in a recent letter, states that this species infests the orange and other citrus fruits, fig-tree, and Japanese privet (*Ligustrum ovalifolium*). It was first described as native of the Hawaiian Islands, and has since been recorded from Mauritius and Brazil (t. Banks). It feeds on *Malva* and other plants. The Bermuda form may possibly be some other closely related species, perhaps *A. aurantii* Mask. See Fig. 184, *d*.

185*a*

186*b*

187

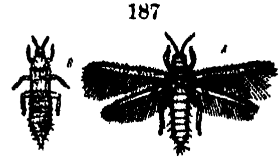


Figure 185*a*.—Chaff-scale (*Parlatoria Pergandii*); *a*, female scale; *b*, male scale; enlarged; after Comstock. Figure 186*b*—San José Scale (*Aspidiotus perniciosus*); *a*, females; *b*, males; *c*, *d*, young; after Comstock. Figure 187—Onion Thrips (*Thrips tabaci*); *b*, larva, all much enlarged From Webster's International Dictionary.

For convenience of comparison I add cuts of several other species of Scale-insects that infest the orange trees in Florida and California. Perhaps all or most of them occur in Bermuda. Figs. 184–186.

Hitherto none of the various small Ichneumon-flies that destroy aphids and scale-insects in N. America and other countries have been found in Bermuda. Like the useful Lady-bugs, they might be introduced with great profit.

Physopoda or *Thysanoptera.* (Thrips.)

Onion Thrips; Tobacco Thrips. (*Thrips tabaci.*) Figure 187.

This very small insect is sometimes so abundant as to do considerable damage to the onion crop, its bites causing the leaves to turn yellow and wither, thus stopping the growth of the bulbs. It spreads very rapidly through the onion fields. The larva is whitish, but the body of the winged imago is blackish. It is very active. Probably spraying with kerosene emulsion is the best remedy, but it should be repeated two or three times at short intervals, in order to reach all of them, for the winged insects can fly away some distance when disturbed and thus many may escape. Solutions of copperas, etc. are used as a spray both against the thrips and the fungous disease. It is considered the same as the thrips that often does much damage to tobacco.

This insect was first recorded as occurring on the onion in Bermuda by A. G. Shipley, Bull. No. 10, p. 18, Miscell. Information, Royal Kew Gardens, 1887. For full descriptions of adult and larva, see Th. Pergande, Insect Life, vii, p. 391–3; and W. E. Hinds, Proc. U. S. Nat. Mus., xxvi, p. 179, pl. vii, figs. 69–71, 1902.

It not only attacks onions and tobacco, but also many other cultivated plants, including melons, cucumber, squash, turnip, cabbage, cauliflower, parsley, and many flowering plants. Its effect on onions is sometimes called "white blast."

In the United States it was first recorded on onions in Massachusetts, and as having been known as early as about 1857. It has long been known as injurious to tobacco in Europe.

k.—Pseudoneuroptera.

Odonata; Dragon-flies.

A considerable number of Dragon-flies, some of them large and handsomely colored, are found in summer. Their larvæ must be very useful in destroying the larvæ of mosquitoes in the marshes and tanks. Whether part of them were introduced by man is uncertain, but there is no reason to doubt that the larger and stronger-winged species might fly directly from the United States, as do some of the butterflies, and thus they may have arrived independently of man. The larvæ or eggs of others may have been brought in the water-casks of vessels, and in other ways.

The following species are recorded, by J. M. Jones, 1876, as identified by Professor Hagen,* except the first, which is by Uhler:

Lestes unguiculata Hagen, Syn., p. 70. Maine and New York to Wisconsin; Missouri.

Ischnura iners Hag.=*Agrion iners* Hagen, Syn., p. 75. Maine; New York to Mexico; Florida; Cuba.

Anomalagrion hastatum Hag.=*Agrion hastatum* Say; Hagen, Syn., p. 77. Maine to Louisiana and Florida; Cuba; Venezuela.

Anax junius (Drury); Hagen, p. 118. New York to Florida; Texas; Mexico; California; Cuba; Hawaiian Islands; China. (See figs. 189, 190.)

Æschna, sp.

Tramea abdominalis Hagen, p. 145. Cuba; Mexico, etc.

Pachydiplax longipennis (Burm.). New York to Texas; Florida; Mexico, etc.

To these should be added at least three more that are not fully determined, for lack of good specimens.

According to the MSS. notes of Miss Victoria Hayward there are at least two additional large species, one of which resembles *Tramea Carolina* Drury, but has a bright blue abdomen; another called by her the "Crimson Dragon-fly" is probably *Lepthemis hæmatogastra* (Burm.).

Agrionina.—This group of small Hammer-headed Dragon-flies is here the best represented. They have the eyes widely separated; the two pairs of wings equal and all narrowed at base, usually with only two transverse antecubital veines; antennæ four-jointed. Some of those seen, which had the abdomen brilliant azure-blue and the wings smoky brown, may belong to *Calopteryx*, but none of this genus were taken.

Lestes unguiculata Hagen, p. 70. A long, slender, brassy-green and brown species, with a median and two lateral lines of yellow on the thorax; abdomen blue, the segments green at distal end; under side and feet black; wings hyaline; pterostigma black; length, 30–34^{mm}; expanse of wings, 36 to 42^{mm}.

Ischnura iners Hagen. Brassy-black, varied with green and blue; wings hyaline, the fore wings of the male black, the apex whitish; pterostigma luteous, rhomboidal.

* Descriptions of all these are in the Synopsis of Neuroptera of North America, by Prof. Hermann Hagen, Smithsonian Miscell. Collections, July, 1861. Many N. American species are figured by Howard, Insect Book, 1901.

Anomalagrion hastatum (Say ; Hagen, p. 77). Brassy-green or blackish, varied with orange and yellow, especially on the sides of the thorax; wings hyaline, remarkable for the singular pterostigma of the fore wings of the male, which is large, rufous, surrounded with yellow and separate from the costal margin; that of the hind wings black, rhomboidal. Those of the female regular, yellowish. See Howard, Insect Book, pl. xlvi, figs. 16–18.

An additional species of *Agrion*, in poor condition, is in our collections. Others were seen, but not captured

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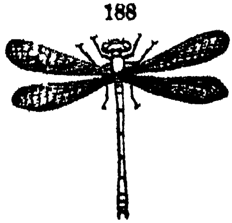

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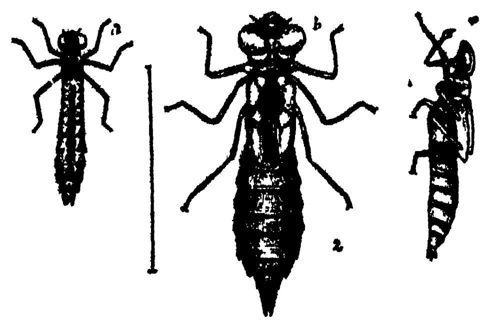


Figure 188.—*Agrion*, sp.; nat. size; not Bermudian Figure 189.—*Anax junius;* *a*, larva; *b*, *c*, pupa; slightly enlarged, after C. B. Aaron.

Æschnina.—Size usually large ; head globular, eyes large, close together or in contact. Wings not petiolate, unequal, the hinder pair broader at base.

Large Blue and Green Dragon-fly. (*Anax Junius* (Drury), Exotic Insects, i, p. 112, pl. xlvii, fig. 5) ; Selys ; Hagen, op. cit., p. 118. Howard, Insect Book, pl. xl, fig. 15.

Figures 189, 190.

This is one of the larger species ; length 68-74^{mm} ; expanse 104–110^{mm}. The thorax is green spotted with blue and fuscous; head yellow, with a blue circle enclosing a black spot above; feet black; abdomen bright blue, except first segment and base of second, which are green, and a fuscous dorsal line. Wings hyaline, yellowish in the middle; pterostigma long and narrow, yellowish.

Very widely diffused, both in the Old World and New; New York to Florida, California, and Texas; Mexico; Hawaiian Islands; West Indies; China, etc.

Two large Dragon-flies, of this species, taken at St. David's I. in October, and sent to me by Miss V. Hayward, before they were fairly dry, agree well together, but differ so much in color from the usual descriptions of this species, that they may indicate a local color variety. The head is bright yellow, as usual, but the circular mark on the vertex of head, with enclosed spot, is black, though showing a tinge of blue iridescence in some lights. Thorax is pale greenish on the sides, but yellowish brown or chestnut above, as is the upper side of the first abdominal segment, and of the second as far as the raised and angulated transverse line, back of which it and the base of the third segment are bright malachite green above;

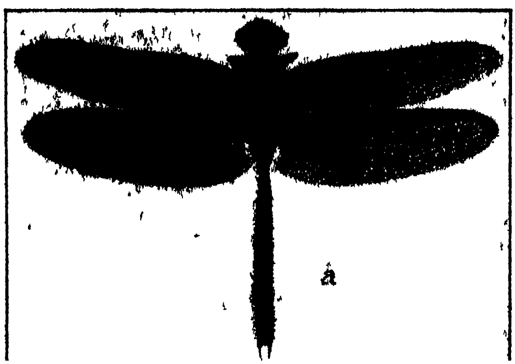


Figure 190.—Dragon-fly (*Anax junius*); $\frac{2}{3}$ natural size; after Drury.

the sides of the first and all of the second segment have the same green color; remainder of abdomen in one example is mostly dull dark brown, with an obscure blackish median stripe, and with a slight tinge of dark blue on the sides; yellowish brown below. In the other the black dorsal stripe is well defined, expanding angularly in one or two places on each segment, and forming a narrow band at each suture; sides yellowish brown crossed by the blackish markings; venter chestnut-brown; anal appendages large, black, flat, with an outer, oblique, distal spur or spine; legs black, becoming dark brown on the femora; wings hyaline, tinged with yellowish centrally; pterostigma large, dark brown; costal margin yellowish; veins nearly black. Antecubitals 15–17; postcubitals 8 or 9. Expanse, 95^{mm} and 105^{mm}; length of largest, 74^{mm}.

A large species occurs, apparently of an *Æschna*, resembling *Æ. virens* Ramb. and *Æ. ingens* Ramb., but I have seen no perfect specimen.

Libellulina.

Tramea abdominalis (Ramb.); Hagen, op. cit., p. 145.

A large species; length, 46^{mm}; expanse, 86^{mm}.

General color of head and body reddish fuscous; feet black; the distal segments of abdomen with a black dorsal stripe. Posterior wings with a narrow fuscous band, veined with yellow, not meeting the anterior margin; anal margin with a small white spot; pterostigma short, brownish black. Native of Mexico and West Indies.

Red Dragon-fly. (*? Lepthemis hæmatogastra* (Burm.); Hagen, op. cit., p. 161.)

The description of a large crimson or red Dragon-fly in the MSS. notes of Miss Victoria Hayward agrees well with this species.

It has most of the head, body, abdominal appendages, and femora red; feet black: front brassy-fuscous; labium yellowish with a median black stripe; wings hyaline, with a fuscous spot at the base of the hind wings in the female; pterostigma red. Length, $45–50^{mm}$; expanse, $70–74^{mm}$. It is found from Georgia and Florida to Brazil.

Pachydiplax longipennis (Burm.); Howard, Insect Book, pl. xlv, fig. 7, female, = *Mesothemis longipennis* (Burm.); Hagen, op. cit., p. 173.

This is a common species of medium size. General color of body fuscous; thorax with two lateral lines of yellow and a transverse line of same at base of wings; abdomen rather short, triquetral, attenuated in male, broader at the apex in female, yellowish, with three broad fuscous stripes above, confluent distally; appendages black; feet black. Wings hyaline, veins black; base yellowish; in the male often dusky at apex; hind wings of male with a double fuscous streak at base; in female wings only slightly yellowish, without basal streaks; pterostigma fulvous. Length, $35–45^{mm}$; expanse, $60–70^{mm}$. Ranges from New York to Florida and Mexico.

Our Bermuda specimen (male) differs from the ordinary form in having the abdomen blue.

Thorax, dark brown or almost black above, with oblique fuscous markings on the sides. Abdomen triquetral, dark blue, fuscous at base on sides and beneath. Legs yellow at base; femora, tibiæ, and tarsi black. Wings slightly fuscous, and especially along the veins, which are black; an orange-brown patch at bases of both pairs;

tips tinged with orange-brown; hind wings broad at base; pterostigma oblong, dark brown; antecubitals 6; postcubitals 6 or 7. Head ochraceous in front, with a dark brown T-shaped mark on vertex; eyes dark brown. Superior anal appendages spatulate, bent down, rugose above. Described from a specimen in formalin. Length, 43^{mm}. The brown patches at bases of wings are unusually large. Identified by Mr. R. P. Currie.

Termites; White Ant. (*Calotermes castaneus* (Burm.); Hagen, Syn. Neurop. N. Amer., p. 1. = *Termes antica* Walker. Plate xcix; figure 16.

Hitherto no species of this group has been recorded from Bermuda. Two winged specimens of a small White Ant were sent in September by Miss Victoria Hayward. The body is brownish yellow; tenannæ and legs paler yellow; wings very long, white, with iridescent luster; costal, subcostal and median veins close together; divergent veinlets pretty numerous, but rather indistinct; antennæ with 14 joints. Length of body (dry), 4^{mm}; length of a wing, 7.5^{mm}; its breadth, 1.75^{mm}. Identified by Mr. N. Banks.

The two specimens sent are alike, but neither is quite perfect The workers were not observed. This species has been taken in San Francisco; common in Central and South America, to Chili and Brazil; West Indies.

Psocids. ***Heteropsocus***, gen. nov.

The small species described below appears to be the type of a new genus, characterized especially by the peculiar simple or primitive venation of the wings (see figures), without cross veins, nearly all veins arising from a central one; by the absence of hind wings in the female and their large size in the male, where they nearly equal the fore wings in size and form. Antennæ with 22–24 joints; palpi 4-jointed; three ocelli in the male. Allied to *Psoquilla* Hagen.*

* Mr. Nathan Banks, who has recently examined the types, furnishes the following additional notes: *Heteropsocus* is nearly allied to *Psoquilla* Hagen, of which a few females have been taken in Europe. The latter in ♀, has also only two wings, marked much as in *Heteropsocus*; but the venation is different; male is unknown. It has been referred to *Atropinæ*, but as the ♂ of *Hetropsocus* has ocelli, it practically breaks up the distinction between Atropinæ and Psocinæ. The male appears to have a median suture on the head.

Heteropsocus dispar Ver., sp. nov. Figures 192, 192*a*, 192*b*.

This elegant little species was found in all stages of development and in large numbers in the black, dry, decayed contents of an old calabash fruit. The male has both pairs of wings longer than the body, well developed and subequal, but the female has the fore wings shorter than the abdomen and the under wings are lacking. The dark brown markings on the fore wings are very conspicuous, in the female forming a leaf-like or fern-like pattern, the dark brown

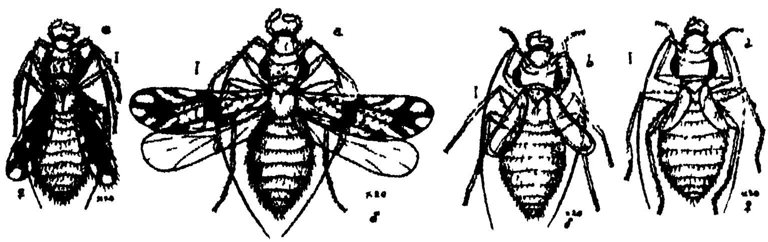
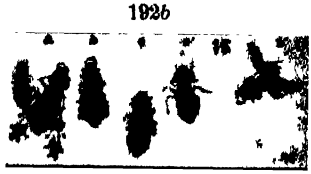


Figure 192.—*Heteropsocus dispar* V.; ×20; *a*, adult male; *b*, male nymph; *c*, adult female; *d*, nymph of female; from drawings by A. H. V.

color continuous centrally, but lobulated along each side, the lobes alternating with clear marginal areas; veins few, not reticulated; veins and margins of the wings are fringed with rather long hairs; end of wings evenly rounded; antennæ dark, very long and slender, equal to or exceeding the body, with 22–24 joints, the two basal ones much thicker than the others; legs long, brown; tarsi three-jointed,

192*b*



194

Figure 192*b*.—*Heteropsocus dispar*, ×8; *a*, male; *b*, *b'*, adult females; *e*, *e*, nymphs. Phot. by A. H. V. Figure 194.—Book-louse, much enlarged; after Comstock.

the proximal joints long, the others short, subequal; claws two, very small. Head large, broad, rounded in front and wide posteriorly; eyes large and prominent, black; palpi clavate; body thick, dark brown or blackish, the thorax paler; abdomen often black. Length of largest females, about 1^{mm}.

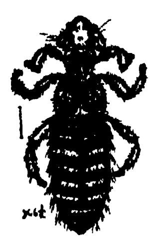
The nymphs are similar, but the body is lighter brown; the head is rather narrower and the eyes less prominent. The male nymphs

have four long, pale wing-pads, which are nearly equal; the females have but two. Larvæ yellowish white and light yellow.

A few males were found; these have two pairs of wings, which exceed the body by about one-third of their length; the two pairs are nearly equal in length and of nearly the same form, but the under wings are transparent, without color markings, and more evenly rounded distally; the median vein of the latter divides near the middle into four branches, of which the distal branch forks once; the fore wings have the brown markings lighter than in the female,

192*a*

193



193*a*

Figure 192*a* —*Heteropsocus dispar* V; wings of male, more enlarged Figure 193 —Louse of tropic-bird, ×6½; 193*a*, the same, dark variety; ×6 From drawings by A H V

and interrupted in the middle, the distal part forming an irregularly stellate or palmate spot, with a veinlet along the middle of each lobe; the three distal branches are bifurcated. Abdominal appendages short, tapered, incurved, hairy, close together; ocelli three, in a triangle between eyes. Length, 1.25mm.

The Book-louse (*Atropos divinatoria*) is common. Fig. 194.

l.—Mallophaga: Bird Lice. Doubtless numerous species occur on poultry, and on the various wild birds that visit Bermuda, but they have not been collected hitherto.*

Tropic-bird Louse. (*Trinoton luridum* Nitz.) Figure 193, 193*a*.

I am indebted to my son, Mr. A. H. Verrill, for several specimens of this large species, from the Bermuda Tropic-bird. The thorax is dark brown or black, the sutures bordered with yellow, and each

* Numerous American species are described and figured by Prof. F. V. Kellogg, in Proc. Calif. Acad. Sciences, vol. vi, pp. 31–168, 431–548, 28 plates, 1896; Occas. Papers Calif. Acad., vi, pp. 1–224, 17 pl., 1899; Journ. N. York Entom. Soc., x, p. 20; List of North American Mallophaga, Proc. U. S. Nat. Mus., xxii, pp. 39–100, 1899. See also Osborn, Bull. U. S. Nat. Mus., No. 7.

segment centered with pale yellow; abdomen crossed by 8 to 10 pale yellow bars. alternating with wider black ones with nearly parallel sides, and usually having a small yellow spot at the lateral ends; sometimes the black bars are so wide that the yellow ones become narrow lines or partly disappear; under surface dark brown; head yellowish with dark brown markings, which usually form two or three distinct small spots on each side. Young are paler brown. Length, 4.5^{mm}. Identified by Professor Kellogg.

It is a very common and widely diffused species, found on various species of ducks, geese, loons, and other aquatic birds. Our specimens differ only in being rather darker in color than usual; and in having the black and yellow abdominal bars nearly straight and parallel, the black bars being scarcely expanded laterally. See Kellogg, New Mallophaga, i, Proc. Calif. Acad., vi, p. 152, pl. xiii, fig. 4, 1896.

It is remarkable that this species, which chiefly infests ducks, should occur on the Tropic-bird, for all the ducks that visit Bermuda in winter depart before the arrival of the Tropic-bird in spring. Moreover the latter breeds in holes in the cliffs and does not frequent the marshes where the ducks occur. Probably these parasites were transferred from ducks at some former period, or in some other country, where the conditions were different. Possibly the Tropic-bird may associate more or less with ducks during its winter migrations.

Bird-louse of Cardinal. (*Docophorus communis* Nitz.) Kellogg, New Mallophaga, i, Proc. Calif. Acad. Science, vi, p. 486, pl. lxvi, fig. 7.

Several specimens of this species were found on a Cardinal by A. H. Verrill. They agree in general with Kellogg's figure of this species, but the thorax is rather shorter and broader, due perhaps to drying. This species has been found on many kinds of passerine birds both in Europe and America. Kellogg records it from the N. American Cardinal and many other birds.

Bird-louse of Bluebird. (*Docophorus incisus* Kell., op. cit., p. 474, pl. lxv, fig. 3, 1897.)

A few specimens probably referable to this species were found on the Bermuda Bluebird by A. H. Verrill. They were perhaps immature and are distorted by drying. Length about 1^{mm}. They

differ from the type in being paler, ochraceous, with no dark markings except an irregular spot of dark brown on the thorax and abdomen. Clypeus strongly emarginate in front. The types were from the N. American Bluebird and Wax wing.

m.—Orthoptera. (Grasshoppers, Cockroaches, etc.)

The only orthopterous insects mentioned by the early writers were cockroaches and a grasshopper. (See p. 737.) The Grasshopper was probably the green *Conocephalus dissimilis* (fig. 191), which is still common in summer.

Spotted-winged Grasshopper. (*Stenobothrus maculipennis* Scud.= *Orphula maculipennis.*)

This small American grasshopper was recorded by Uhler, from Heilprin's collection.

S. bilineatus Scudder, a common North American species, was identified by Scudder from Jones' collection, 1876.

Carolina Grasshopper; Quaker. (*Dissosteira Carolina* Scudder= *Œdipoda Carolina* Burm.) Plate xcix; figure 18.

This large species, which is abundant in all parts of eastern North America, from Canada to Texas and New Mexico, and also occurs in the West Indies, was recorded by J. M. Jones, in 1876. It is usually found in dry or sandy places, or in roads where its dull gray-brown color imitates the color of the ground. When it flies its large yellow and black wings are conspicuous. Its name "quaker" probably alludes to its loud quaking note, made during flight, as well as to its dull external colors.

Green Grasshopper. (*Conocephalus dissimilis* Serv.) Figure 191.

This species, when living, is bright light green in color and the female has a very long, flat ovipositor; there is a fusiform, transverse, blackish spot across the front of the obtusely conical head.

This species, which has been determined by Mr. Samuel Henshaw, is one of the very numerous species known from the West Indies and tropical America, though it probably reached Bermuda by natural agencies, before the settlement. Still it is not easy to explain how an insect of this kind could have been transported to this distance by ordinary natural causes.

Small Green-grasshopper. (*Orchelimum vulgare* Harris.)

Recorded by Uhler from Heilprin's collection. A common species of the eastern United States.

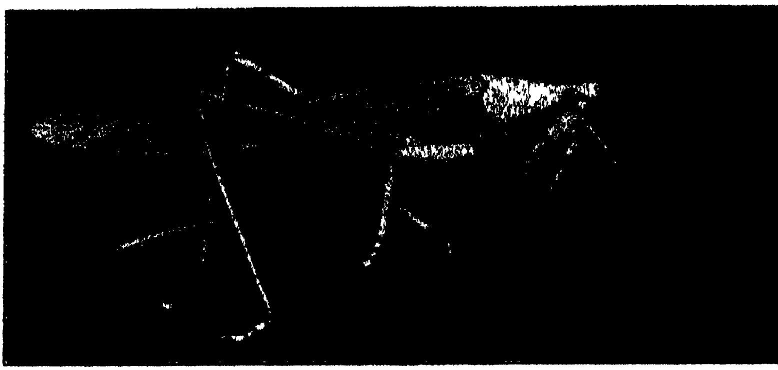


Figure 191.—Bermuda Green Grasshopper (*Conocephalus dissimilis* Serv.); × 1⅓.

American Black Cricket. (*Gryllus luctuosus* Serv. and *G. abbreviatus* Serv.) Figures 195, 196.

The large crickets are common, especially in muddy places near the shore. Specimens with long wings and others with short wings occur together, as in the United States, the short-winged ones being more numerous. These are *G. abbreviatus*, but the two kinds are considered only dimorphic forms of one species. It varies widely in

Figure 195.—American Black Cricket (*Gryllus abbreviatus*); female; nat. size; after Comstock.

color, from brown and mottled to black, and occurs from Massachusetts to Florida. It is very nearly allied to *G. Pennsylvanicus* Burm. = *G. neglectus* Scud., which often occurs with it in the United States, and may, perhaps, also occur in Bermuda, for some of the specimens agree pretty closely with the latter.

The form *G. luctuosus*, with long wings, was recorded by Uhler.

Dr. Fr. Dahl recorded the genera *Cylindrogryllus* Sauss. and *Orphula* Stål, 1873 = *Stenobothrus*.

Two-lined Walking-stick. (*Anisomorpha buprestoides* (Stoll.) Gray; Uhler in Say, Ent., i, p. 198=*Spectrum bivittatum* Say, Ent., i, pp. 83, 198, pl. 38, ♂ and ♀.)

FIGURE 197.

Mr. Samuel Henshaw informs me that this phasmid was collected in Bermuda many years ago (about 1861) by Mr. A. S. Bickmore.

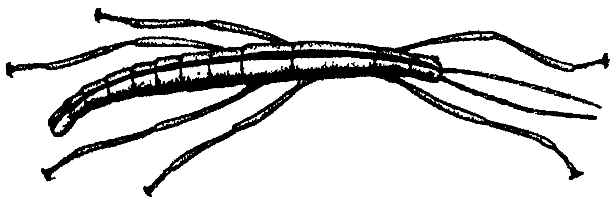


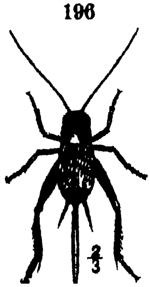
Figure 197.—*Anisomorpha buprestoides;* male, × $1\frac{1}{2}$; after Say.

It is native of the United States, from southern New York and Nebraska to the Gulf of Mexico. Figured also by Glover, Ill. N. Amer. Ent., Orthop., i, pl. i, fig. 8.

Mantis. (*Stagmomantis*, sp.)

A species of this genus of Mantidæ has also been found by Mr. Henshaw in Bickmore's collection. It is congeneric with the common mantis of the eastern United States (*S. Carolina* (L.).

196



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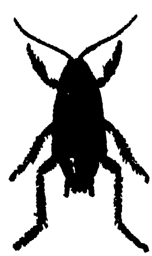

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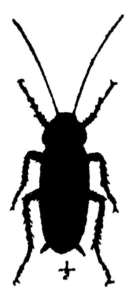

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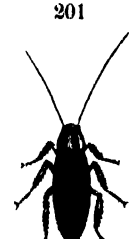


Figure 196 —Black Cricket (*Gryllus abbreviatus*); female, $\frac{2}{3}$. Figure 198.—American Cockroach (*Periplaneta Americana*); female, about $\frac{2}{3}$ nat. size. Figure 200.—Oriental Cockroach (*Stylopyga orientalis*); male, $\frac{1}{2}$. Figure 201.—Water-bug (*Ectobia Germanica*), nat. size. All from Webster's International Dictionary; 196 after Harris.

Blattidæ. (Cockroaches.)

Cockroaches were mentioned by the early writers (see quotation, p. 737), but whether they were native or had been introduced by the

early settlers is uncertain. It is quite likely, however, that like the wood-rats they may have been introduced from the West Indies by earlier visitors.

Cockroaches are much less numerous here than might be expected in so warm a climate. They are undoubtedly kept in check to a great extent by the common ichneumon parasite (*Evania appendigaster*, p. 754, fig. 109), which destroys the eggs in the egg-capsules. The Agua Toad also feeds largely on cockroaches, as shown by its stomach contents. They are also destroyed by the larger spiders and centipedes.

American Cockroach. (*Periplaneta Americana* (L.) Burm.; Sauss.)

FIGURES 198, 199. PLATE XCIX, FIGURE 19, *a*.

Very common and perhaps indigenous. It is one of the most abundant species here. Supposed to be of American origin, but now found in nearly all warm countries, especially on the sea-coasts. It sometimes lives among and under the decaying debris, just above high-tide, but is mostly found in houses and stores and on ships.

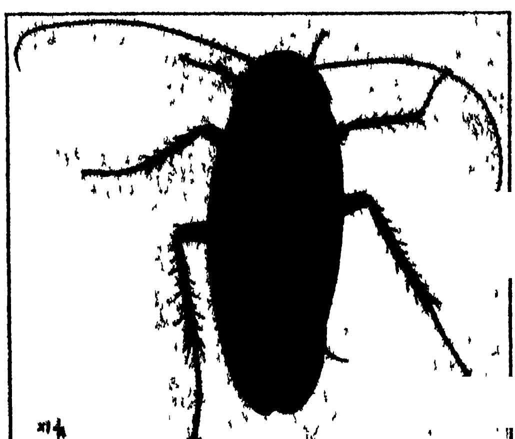


Figure 199.—American Cockroach; a large male; about nat. size. Length 43mm. Phot by A H V. from a Bermuda specimen.

It is yellowish or rusty brown, but the thorax (pronotum) is usually marked with a sub-marginal pale yellowish band, and often with a triangular median spot of the same, which may be divided. The elytra of the male reach decidedly beyond the end of the body; in the female they are much shorter. The adult male is decidedly

larger (about 20 per cent.) than the female, and flies with great facility; length 38–43^{mm}.

Cockroaches were mentioned as abundant, by Gov. Butler, 1619, (see p. 737). In 1676 complaints were made that the cockroaches were rapidly destroying the public records, and cedar chests were ordered made, in order to preserve them from further destruction. These early cockroaches were probably this species.

Australian Cockroach. (*Periplaneta Australasiæ* (Fabr.) Brunn.; Sauss., Mem. Hist. Nat. Mex., iii, p. 72, 1864.)

PLATE XCIX; FIGURE 20.

Similar to the preceding, but the male is rather smaller; the elytra extend a little beyond the body and are about equal in the male and female; the prothorax is more transverse and more elliptical, or relatively shorter; less prolonged anteriorly. The pronotum has a pale yellowish submarginal band, wider medially, and externally bordered with very dark brown; the central-spot is dark brown and usually somewhat bilobed; the elytra have a conspicuous short scapular bar of yellowish white; basal part dark rufous brown, chestnut brown distally. Length of head and body in both sexes, 28–30^{mm}; of elytra 22–23^{mm}. The caudal appendages of the male reach about to end of elytra. The larva has a row of yellow spots on the sides of all the segments.

Nearly cosmopolitan in warm countries: North America, from New England and Nebraska to Florida and Mexico; West Indies; South America; Europe; Asia; Africa; Australasia, etc.

This species was identified by Mr. Samuel Henshaw, from specimens in our collections, both of 1898 and 1901. It is a common species at Bermuda, both in the fields, under stones, and in buildings.

Oriental Cockroach; "*Black-beetle.*" (*Stylopyga orientalis* (L.) Fisch.; Gerst.; Sauss.) Figure 200.

This large, plain, dark brown species, which is the "black-beetle" of English kitchens, is mostly confined to dwellings and ships. Its wings are small, even in the adult male; nearly abortive in the female.

Surinam Cockroach. (*Panchlora Surinamensis* (L.) Sauss.; Brunn.)

PLATE XCIX; FIGURE 19, *b*.

This species, which is common, is about an inch long when mature, and rather broad; the elytra are wide and longer (about 5^{mm}) than

the body, ferruginous-brown, paler at the anterior or basal margin, and with a short humeral black line; prothorax brownish black, the anterior margin testaceous; vertex of head blackish. A variety from Bermuda, according to Saussure, has the thorax brownish black with a testaceous line on each side of the anterior margin.

Widely diffused in the West Indies and East Indies; New Orleans; Paris, France (Sauss.); S. America; St. George's, Nov., L. Mowbray, var.

In this genus the prothorax is roundish, not truncated posteriorly, but convexly arched or angulated in the middle.

Madeira Cockroach; "Knocker." (*Panchlora Maderæ* (Oliv.) Sauss.)

This large species is very common in storehouses. When mature it is nearly 2 inches long (48^{mm}), including the elytra, which extend about 8^{mm} beyond the end of the abdomen. It is fuscous or yellowish brown, the elytra paler or more yellowish than the body. The pronotum is short and broad, ornamented with a double row of dots, which form a lyre-shaped or V-shaped figure with the angle rounded; or sometimes it is shield-shaped. Supposed to be of African origin, but now widely diffused in the East and West Indies; Africa; South America; Mexico, etc.

This is probably the species called by the Bermudians "Knocker" or "Drummer," owing to the loud noise that it makes at night. At least it was the only large species that I found in places where the noise had been heard. This name and the noise have, however, usually been attributed to a different and larger species (*Blabera gigantea* (L.) Sauss.) in the West Indies, but I am not aware that the latter has been found in Bermuda. Possibly several large species have the power of making the same noise. This was first recorded by Uhler, from Heilprin's collection. Probably other undetermined species of cockroaches occur in Bermuda.

Water Bug; Croton Bug. (*Ectobia Germanica* (L.) Steph.; Scud.)

FIGURE 201.

We were told that this small species occurs in some dwellings, but obtained no specimens. It is widely diffused in most countries.

Ceratinoptera diaphana Brunn.; Sauss., Mex. Rech. Zoöl., vi, p. 20, pl. i, fig. 17, 1870.

Recorded by Jones, 1876, from specimens identified by S. H. Scudder. A small cockroach, native of the West Indies.

Wingless Cockroach. (Subfamily, Panestrinæ, t. A. N. Caudell.)

Head small; body obovate, widest behind the middle, abdomen about 3 times width of head; total length, 16^{mm}; breadth of head, 3.25^{mm}; of abdomen, 10^{mm}. Color, above, dark brown, smooth and lustrous as if varnished back to 4th abdominal segment, beyond which it is dull blackish brown; integument very firm, minutely punctate; under side and legs light chestnut-brown; head deeper chestnut; mouth-parts, anterior border of clypeus, and base of antennæ brownish yellow; vertex of head with an ill-defined chestnut-brown patch. The tarsi are broken, so that the species is indeterminable. St. George's, Oct., L. Mowbray.

Phyllodromia (?), sp.

A nymph obtained in April is doubtfully referred to this genus by Mr. Caudell. It is chestnut-brown; lateral marginal streak on the thorax and abdomen, sutures, and middle of prothorax paler; length, 19^{mm}; breadth, 7.5^{mm}.

n.—*Dermaptera.* (Earwigs.)

Great Sea-side Earwig. (*Labidura riparia* (Pallas) Dohrn = *L. gigantea* (Fabr.) Fisch.) Figure 202.

This, which is perhaps the largest species known, is not uncommon here, occurring among debris along the shores, and also in storehouses. It is very widely distributed in the warmer parts of both hemispheres, including Europe and the southern United States.

Black Sea-side Earwig. (*Anisolabis maritima* Fieb.; Scudder, 1876 = *Forcinella maritima* Scudder, in Jones.) Plate C; figures 6–9.

This large, widely distributed species is common under decaying debris and stones at high-tide mark. It may have been indigenous here. It is found in the same way on the American coast, as far north as the Thimble Islands, near New Haven, Conn., where I have found it abundant in recent years.* West Indies; Brazil; Japan; Europe; and coasts of most warm countries.

* It seemed possible at first that this earwig was accidentally introduced into these islands by me, in 1898, for my dredges, nets, ropes, etc, were sent directly to Outer Island, on my return from Bermuda that year, without being unpacked in New Haven.

I had not noticed them previous to 1900; but on the other hand I had not

Both sexes are completely apterous when adult, and nearly black; the young are grayish or dusky, and very active.

Anisolabis antennata Kirby, sp. nov., was described from Bermuda, Journ. Linn. Soc., xxiii, p. 517, 1891.

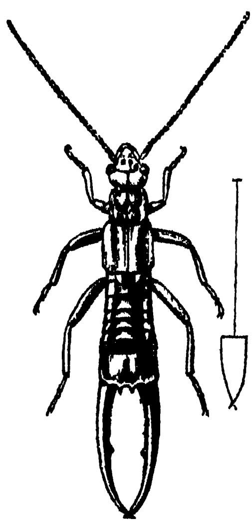
o.—Thysanura.

Silver-witch ; Slicker ; Shiner. (*Lepisma saccharina* L.)

FIGURE 204.

Found in houses and outbuildings, often among books and papers. Widely distributed in most countries. Probably *Lepisma*, or *Ther-*

202



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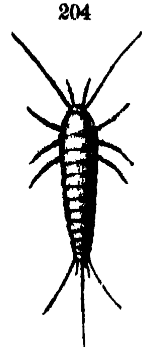

Figure 202.—Great Earwig (*Labidura riparia*); ×1½; after Claus. Figure 204.—Silver Witch (*Lepisma saccharina*); × 2; after Packard.

mobia, domestica Pack.) would be found in bakeries and kitchens if looked for.

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looked for them here. They are now, July, 1902, very abundant, though the past winter has been of such unusual severity that most of the native cockroaches, usually very abundant under the decaying debris along the beaches, were nearly all exterminated, while the earwigs, of all sizes and in great numbers, are to be found in the same places. On recently visiting other islands of the group to look for the species, I have found it equally abundant on several of them and on the adjacent mainland, thus indicating that it was introduced at some earlier period.

38.—*Introduction of Arachnids and Myriapods.*

a.—*Araneina* (Spiders).

The only native spider mentioned by the early writers was the great Silk-spider (*Nephila clavipes* Fabr.). Figures 205, *a*, *b*.

At first it was thought by the settlers that its strong silk was that of a silkworm, and later that it indicated conditions favorable for the production of commercial silk.

The following is Strachy's account of it, 1612:

"Certaine spiders, indeed, of a very large size, are found hanginge upon the trees; but insteade of being dangerous, or any way harmefull (as in other places), they are here of a most pleasinge and beautifull aspect, all over as it were, deckt with silver, gold, and perle;* and their webbs (woven in the sommer upon trees) are found to be perfect silck, and that as well in respect of substance as coulour, and so stronge they are generally that birds bigger and by much stronger than sparrowes, are often taken and snarled in them as in netts."

Richard Stafford, in a letter to the Royal Society of London, written July 16, 1668, and published in its Transactions, describes its habits as follows:—

"Here are Spiders, that spin their Webbs betwixt Trees standing seven or 8 fathom asunder; and they do their Work by spirting

* The colors of adults, after brief preservation, as studied by me, are as follows. The color of the abdomen varies considerably; the largest ones are reddish brown, chestnut-brown to brownish yellow, often with an orange tint posteriorly; a narrow, pale silvery band crosses the anterior part of the abdomen, just back of the hump; two dorsal rows of small, round, pale silvery or golden spots, four or five spots in each row; numerous other smaller silvery or golden spots, irregular in shape, are scattered over the abdomen, most numerous on the sides and posterior end; a silvery cross-band also occurs on the under side, anteriorly; also small blotches, which sometimes form two lateral streaks and a bracket-shaped transverse line on the middle area. Dorsal surface usually has a dark median line with irregular dark lines diverging backward from it; dark brown around the spinnerets.

Thorax above dark brown, but thickly covered with silvery scales; beneath, dark brown; Falcers and distal joints of palpi black; legs dull orange-yellow or orange-brown, with a wide band of dark brown or black at all the joints; plumose hairs black; tarsi long, blackish, except proximally.

The larger examples are 5.25 to 5.50 inches (130–140^{mm}) across the outstretched legs; length of body, 26 to 30^{mm}; of abdomen, 23^{mm}; breadth of abdomen, 12^{mm}. Adults, taken late in summer, were sent by Mr. T. G. Gosling.

their Webb into the Air, where the Wind carries it from Tree to Tree This Webb, when finisht, will snare a Bird as big as a Thrush. Your self may prove it, for I have sent you some."

No representatives of the Harvest men (*Phalangidæ*), Scorpions,* Whip-scorpions, nor Book scorpions, are yet known in Bermuda

Large spiders of the *Mygale* group have not yet been reported.

Of the 33 species of spiders now recorded from Bermuda† only

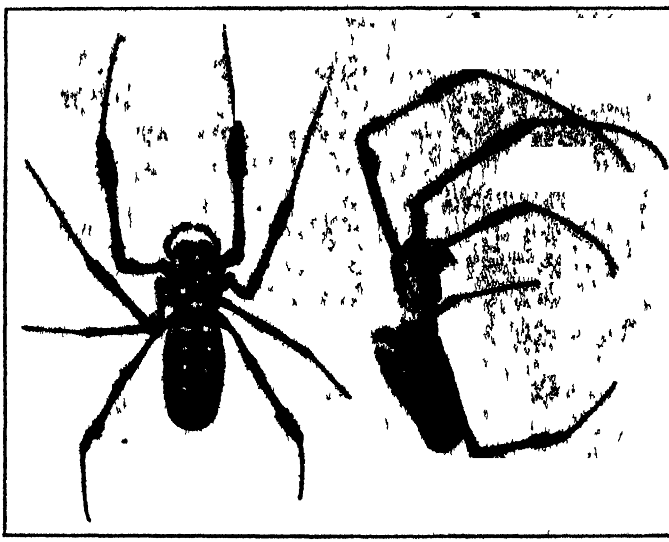


Figure 205 —Silk Spiders, both females; *a*, dorsal, *b*, profile view, ¼ nat size Phot by A H V

two or three are peculiar to the islands, so far as positively known. Most of the others are either widely diffused species, or else pertain to the West Indies and southern United States. Some of the latter may have been indigenous, like the Silk-spider, but most of them have undoubtedly been introduced by commerce, for spiders are admirably adapted for transportation by vessels.

* After the above was in type, Mr L Mowbray of St George's informed me that he found a scorpion under a stone, several years ago, and that it is still preserved in St. George's The species is not known. He also says that a vessel loaded with logwood had arrived a few years previously and that scorpions were found in her cargo. Whether any other specimens have been found, I do not know Such a species might easily become naturalized about St George's, where there are plenty of ancient stone walls, and long escape observation.

† A nearly complete list of the known spiders of Bermuda is given by Nathan Banks, in Trans. Conn Acad., xi, p. 267, 1901. The present list is based on the latter

The most prominent species, aside from the Silk-spider, is the great brown House Spider (*Heteropoda venatoria*), which is very common. Fig. 206.

The cosmopolitan species were probably mostly introduced from Europe by the early settlers, while the tropical American forms were mostly brought from the West Indies. Probably every vessel that arrives brings numerous spiders, some of which may easily be naturalized. Doubtless there are numerous additional species, not yet recorded from the islands.

The following species are generally distributed in both hemispheres:

Tegenaria Derhami Scop.

Pholcus tipuloides Koch. (Fig. 212.)

Theridium tepidariorum Koch; House Spider. (Fig. 213.)

Theridium rufipes Lucas; House Spider.

Uloborus geniculatus Olivier. (Fig. 215.)

Heteropoda venatoria (L.); Great House Spider.* (Fig. 206.)

Tapinattus melanognathus Lucas; Black Jumping Spider. (Fig. 222.)

Plexippus Paykulli Aud. and Sav.; Jumping Spider. (Fig. 223.)

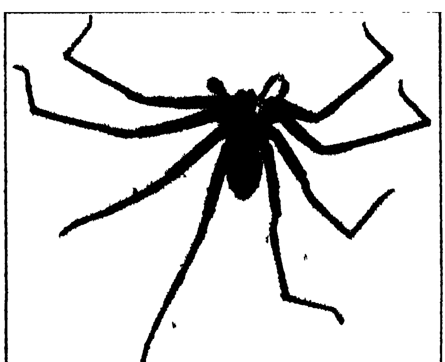


Figure 206.—Great House Spider (*Heteropoda venatoria*); $1\frac{1}{2}$ natural size. Phot. by A. H. V

The following are native of the West Indies and southern United States:—

Loxosceles rufescens Lucas.

* Very common in outbuildings; runs and jumps with great agility. The larger ones are 4.5 to 5.25 inches across the outstretched legs.

Filistata hibernalis Hentz; Large Brown Spider. (Figs. 210, 211.) A rather large brown house spider.

Scytodes longipes Lucas.

Scytodes fusca Walck.

Lathrodectus geometricus Koch; Venomous Spider. (Figs. 214, *a*, *b*.) Abdomen light gray, with darker gray markings.

Argyroepeira hortorum Hentz; Silvery Spider. (Fig. 218.) Abdomen with silvery marks.

Nephila clavipes Fabr.; Silk Spider. (Fig. 205.)

Epeira labyrinthea Hentz. (Fig. 219*a*, 219*b*.)

Oxyopes salticus Hentz.

The following are native also of the West Indies:—

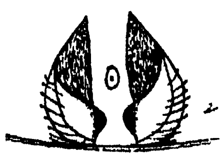
Epeira gracilipes Blackw. = *E. Theisii* Walck.

Anyphæna Verrilli Banks, op. cit., p. 270, fig. 2. Fig. 207.

Eutichurus insulanus Banks, op. cit , p. 270, fig. 3. Fig. 208.

Wala vernalis Peckham; Jumping Spider.

207



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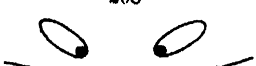

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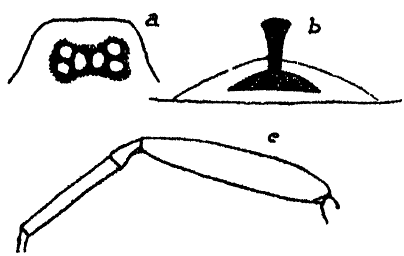


Figure 207.—*Anyphæna Verrilli;* epigynum. Figure 208.—*Eutichurus insulanus;* epigynum. Figure 209.—*Oonops Bermudensis ; a*, eyes ; *b*, epygynum ; *c*, hind leg. Drawn by Banks.

The following is from Europe and North America:—

Dysdera crocata Koch.

Easily recognized by its orange-red or saffron-colored body. Common under stones.

The following are found in the southern United States :—

Theridium studiosum Hentz.

Cyclosa caudata Hentz. (Fig. 216.)

Argyrodes nephilæ Tacz.

Anyphæna velox Becker.*

* Mr. N. Banks informs me that he has recently examined specimens of this species from St George's (U. S. Fish Com.). It is a pale-colored species, about 16^{mm} long, with porrect mandibles, especially long in the male. It is known from southern Florida (t. Banks).

Two or three species that appear to be endemic are known only from Bermuda, but they may eventually be found in the West Indies. These are as follows:—

Thomisus (*Xysticus*) *pallens* Blackwell.

Oönops Bermudensis Banks, op. cit., p. 269, fig. 1, 1902. Fig. 209.

Lycosa Atlantica Marx, type from Bermuda. It may be the same as *L. fusca* Keys., from Cuba (t. Banks). Fig. 220. A dark brown or almost black Wolf-spider.

Dr. Fr. Dahl (Plankton Exped., i, pt. 1, p. 110, 1892) recorded undetermined species of *Clubiona* and *Trochosa*.

Notes on Colors of the Spiders.

The following notes were made on the size and colors of a part of the spiders, after they had been preserved for a short time in formalin solution; apparently the colors had not much changed, but the size of the abdomen was often considerably diminished by hardening and shrinking.

Filistata hibernalis Hentz; Large Brown Spider. Figures 210, 211.

Cephalothorax of a female, orange-brown or rufous, a black patch between the eyes; legs of the same color, with narrow bands of white at the joints beneath, and becoming blackish at tips, partly covered

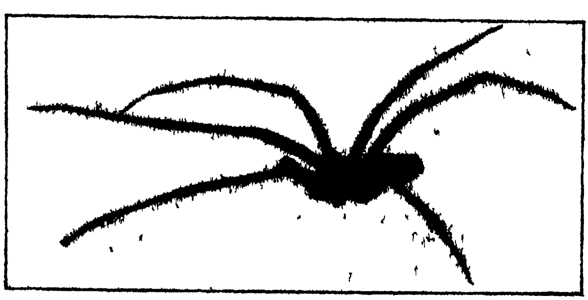


Figure 210.—*Filistata hibernalis* Hentz; male; slightly enlarged. Phot. by A. H. V.

with scattered black hairs; falcers small, dark brown, with black hairs, the terminal piece black; abdomen plain pale buff with black hairs, not crowded; palpi stout and short, deep orange-brown, like the legs, black distally.

Length of body of female, about .75 inch (18 to 20^{mm}).

The male (see fig. 210) has much longer and more slender legs and palpi, and smaller body. Color lighter yellowish brown, with black hairs. Lives in outbuildings, making a large, dense web, with a deep funnel-shaped den behind timbers and in other similar places.

Scytodes longipes Lucas ; Long-legged Spider.

Although the body is small (about 9–10^{mm} long), the legs are very long, the anterior ones being about 65 to 70^{mm}, or about 2.5 inches long. In an adult male they are orange-brown, with a conspicuous brownish black band at the knee joints, and fainter narrow dark brown bands or blotches on the femora, with a larger dark spot on the basal joint beneath; Cephalothorax tawny brown, mottled and specked with darker brown and pale yellow, and having a rudely lyre-shaped dorsal blackish area, enclosing a light yellow area, with golden reflections when dry, from which a pale line runs on each side to the prominent, black, lateral or posterior eyes, which are situated far back, and a median pale line goes to the pair of closely conjoined anterior eyes. On the black, lyre-like patch are about six small, pale yellow, roundish spots, having a silvery or golden luster when dry, forming a somewhat circular group ; others that are less distinct are scattered on the sides ; posterior area silvery, preceded by a blackish blotch.

The female is similar but darker, with the dark markings more distinctly blackish, and with the legs darker and more conspicuously banded or else spotted with blackish on most of their length. It is a very active species, which lives in large loosely constructed webs, especially in the mouths of caverns. It runs over the webs with great agility by reason of its long legs.

Dysdera crocata Koch ; Orange Spider

Cephalothorax and legs plain bright orange-rufous or reddish brown, above and below; eyes black; abdomen pale buff or grayish. Length 12–13^{mm}. Common under stones.

? *Hypsinotus pumilis* Keys. See Banks, p. 270. Brown Spider.

A rather large orange or reddish brown spider, with stout legs. Cephalothorax plain dark reddish brown posteriorly ; blackish anteriorly ; abdomen dark tawny brown, with a median sagittate pale streak, its shaft crossed by several recurved, narrow pale lines.

Tegenaria Derhami (Scop.) Emer.; Black House Spider.

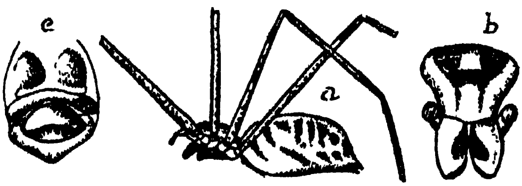
Cephalothorax black with a deep reddish brown or brownish red central area; abdomen nearly black, with a pale median streak and a short oblique lateral stripe on each side; legs dark rufous-brown without bands.

Pholcus tipuloides Koch; Long-legged Spider. Figures 212, *a*, *b*, *c*.

Cephalothorax and abdomen light yellowish brown or buff, with curiously bent or undulated blotches of blackish brown on the sides of the abdomen, which has also a median streak anteriorly and a

212

e b



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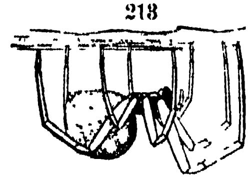

Figure 212.—*Pholcus tipuloides; a*, profile view of body and bases of legs of female, $\times 2\frac{1}{2}$; *b*, front of head; *c*, epigynum; after Marks. Figure 213.—House Spider (*Theridium tepidariorum*): female, slightly enlarged; after Emerton.

double dorsal row of spots farther back; cephalothorax with a median streak, two or three angular lateral spots, and a black margin; legs very long and slender, brown, with a narrow band of white at the joints, preceded and often followed by an ill-defined band of brown.

Theridium tepidariorum Koch; House Spider. Figure 213.

Cephalothorax in female tawny brown; abdomen light gray or yellowish gray, irregularly specked or mottled with dark brown or blackish; legs tawny brown, with dark brown bands at the joints.

Theridium studiosum Hentz. House Spider.

Thorax and legs pale rufous-brown, a few darker brown bands on the legs; abdomen gray, with a wide, lobulated, median, dorsal streak of blackish gray, edged with white.

Lathrodectus geometricus Koch; Venomous Spider. Figure 214, *a*, *b*.

The abdomen is light grayish yellow, finely specked with brownish anteriorly; always marked with curiously arranged, narrow, blackish

or dark brown lines, often very distinct, producing a map-like effect. There are often three or four divergently transverse black lines, and a posterior median dorsal one, and usually two small rhombic or cordate median dorsal areas, enclosed by narrow dark lines, and a smaller rounded one farther forward; the sides are covered with curved or wavy lines enclosing irregular areas; three small, dark

211 214

Figure 211.—*Filistata hibernalis*, female; slightly enlarged. Figure 214 — Venomous Spider (*Lathrodectus geometricus*), *a*, female with cocoon; *b*, another female, about nat. size. Phot. by A H V.

brown, roundish spots on each side; legs rufous-brown, with dark brown bands at the joints; spinnerets surrounded by a black ring interrupted by five or six white spots. The eggs are large, enclosed in a tough spheroidal cocoon, to which the female clings tenaciously. Found on fences, etc. Length of body of female, 8–10^{mm}; abdomen, 6 to 7^{mm}.

Bathyphantes, sp. A small, plain, slate-colored spider.

Uloborus geniculatus Oliv; Ring-legged Spider. Figures 215, 216

Adults are conspicuously marked with black spots and rings. Cephalothorax nearly black, with a lanceolate pale spot posteriorly;

215 216

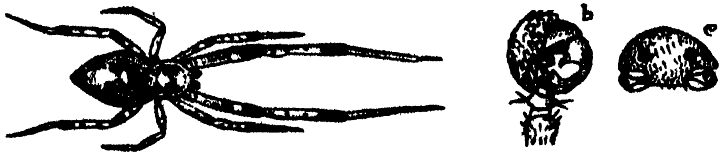

Figure 215 —Ring-legged Spider (*Uloborus geniculatus*); *a*, dorsal view of female, × 1½; 216—*b*, palpus of male, *c*, epigynum; after Marx.

abdomen dark gray or pale gray, thickly specked and blotched with black, the black often predominant; legs yellowish brown, or light

gray, broadly banded with black; the black often prevails, so that they appear black with narrow whitish bands. Young ones are pale with narrow black bands on the legs. One adult female is tawny brown on the thorax, with a pair of lateral crescent-shaped spots of yellowish on the sides, besides the posterior spot; abdomen grayish brown; large anterior legs tawny or rufous, with wide black bands; others with black and white bands.

Cyclosa caudata (Hentz) = *C. conica* Emert. Figures 217, *a*, *b*.

Color varied with gray, black, and white, with some yellow, in variable proportions, some being light and others dark gray; cephalothorax often dark gray or black, legs white annulated with black at the joints and usually between them; abdomen dark below.

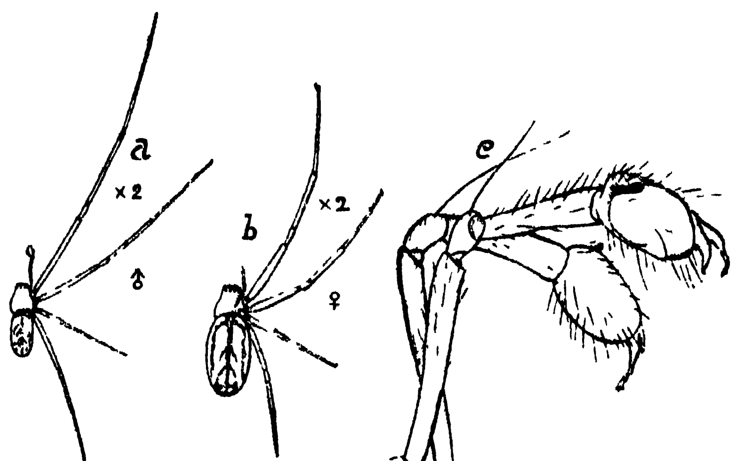

Figure 218.—Silvery Spider (*Argyroepeira hortorum*); *a*, dorsal view of male; *b*, dorsal view of female, ×2; *c*, male palpi; much enlarged; after Emerton.

Length 5 to 6^{mm}. The hump on the abdomen of the female is variable in size, and is scarcely noticeable in the smaller male.

Its habits in Bermuda are the same as described by Emerton for it in New England:

"This species seems to live all the time in the web. Across the web there is usually a line of dead insects and other rubbish fastened together with a quantity of loose web in which the cocoons are also concealed. The spider standing in the middle of this band, where it crosses the center of the web, looks like part of the rubbish."

Argyroepeira hortorum (Hentz) Emert.; Silvery Orb-web Spider. Figures 218, *a*, *b*, *c*.

Abdomen pale yellowish brown or buff, with large irregular patches of bright silvery white; thorax plain yellowish; legs pale brownish yellow, becoming tawny distally; falcers dark brown.

Epeira labyrinthea Hentz; Emert., Trans. Conn. Acad., vi, pl. xxxiv, fig. 8; pl. xxxvi, fig. 11. Figures 219*a*, 219*b*.

Cephalothorax dark brown, with a white patch around the eyes, and smaller ones on the sides; abdomen whitish, with a distinct lobulated dark brown or blackish figure on the posterior half, including some white spots anteriorly; dark below, with a median pale line; legs white with narrow dark brown annulations at the joints. Length of female, 5^{mm}.

219*a*. 219*b*.

217

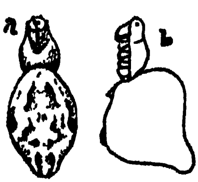

Figure 217 —*Cyclosa caudata*, *a*, dorsal; *b*, profile view of female, enlarged about 4 times; after Emerton. Figure 219*a*.—*Epeira labyrinthea*; *a*, dorsal view. Figure 219*b* —The same; male palpus, after Emerton

Heteropoda venatoria (L.); Great House-spider. Figure 206.

Color dull grayish brown or yellowish brown, with scattered blackish hairs; on the legs black specks at the base of hairs. Length of body sometimes $22–24^{mm}$; expanse of legs may be 130^{mm}, or about 5.25 inches. Takes its prey by chasing or jumping upon it, like the Wolf-spiders. In spite of its evil Latin name it is considered harmless by the natives, and is also useful in killing cockroaches and other vermin.

Lycosa Atlantica Marx ; Common Wolf-spider. Figures 220, 221.

The color of this species is variable. In some of our specimens preserved in formalin the cephalothorax is dusky or tawny brown, with a narrow median stripe of lighter brownish yellow, wider anteriorly, and a curved lateral stripe of the same color on each side and of about the same width ; extreme margin edged with a narrow black line ; abdomen brownish black thickly covered with short black hairs, and with a faint median stripe of pale brown anteriorly,

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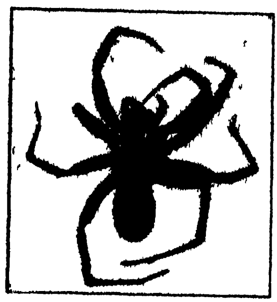

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Figure 220.—Wolf spider (*Lycosa Atlantica*); dorsal view, ×1½; phot. by A. H. V. Figure 221.—The same ; epigynum ; after Marx.

more visible while wet, and sometimes divided by a median dark stripe ; often, also, a pale lateral line on each side ; sometimes the pale dorsal abdominal streak is forked anteriorly, enclosing a forked black streak, which encloses a short median yellow streak or spot. Frequently the abdomen is plain blackish or smoky brown, or dark gray. Length of body 10–13^{mm}.

Lycosa, sp.; Brown Wolf-spider.

A large, nearly plain, tawny-brown species with many small, indistinct, dark roundish spots on the abdomen ; legs plain orange-brown, with reddish joints ; cephalothorax and abdomen blackish below. Length about 38–40^{mm}.

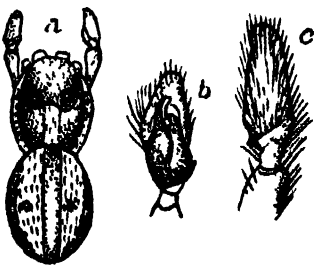
Walu vernalis Peckham ; Little Brown Jumping Spider.

Cephalothorax plain tawny or rufous-brown ; abdomen plain light yellowish brown ; legs similar to abdomen in color except the stouter anterior pair, which are rufous-brown, like the cephalothorax ; no bands on the legs. Length of female about 6^{mm}.

Tapinattus melanognathus Lucas; Black Jumping Spider. Figures 222, *a*, *b*, *c*.

Cephalothorax plain black, with gray hairs; abdomen black, with a wide, irregularly lobulated median patch, divided anteriorly by a median black streak; its lateral margins and under surface also pale; legs tawny brown, with blackish spots; falcers and under side of thorax black. Length of a female 8^{mm}.

222



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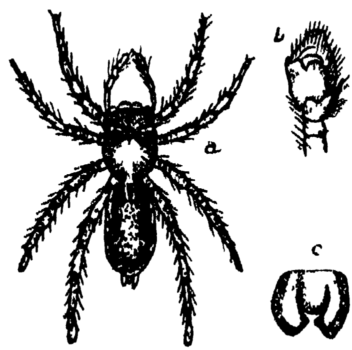


Figure 222.—*Tapinattus melanognathus*; *a*, dorsal view of body of male, ×3½; *b*, *c*, palpi of male; after Marx. Figure 223.—*Plexippus Paykulli*; *a*, dorsal view of female, ×2; *b*, male palpus; *c*, epigynum; after Marx.

Plexippus Paykulli Aud. and Savig.=*Menemerus diversus* Black.; Large Jumping Spider. Figures 223, *a*, *b*, *c*.

Cephalothorax of male dark brown or blackish, with a median streak of dull reddish brown or tawny, not reaching forward to the eyes; abdomen mottled with dark brown and gray; legs dark tawny brown, covered with conspicuous black hairs, but not banded. Length 9–11^{mm}.

b.—Acarina. (Ticks and Mites.)

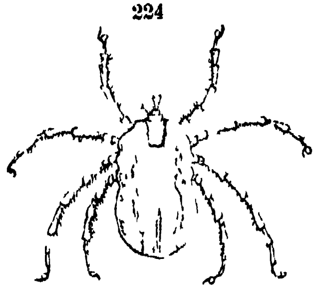
An undetermined species of tick (*Ixodes*) was recorded by Hurdis (Rough Notes, p. 328) as found in large numbers on the leg of a heifer. It was white and the size of a pea. Mr. Nathan Banks,* 1901, recorded a North American mite (*Actineda agilis* Banks), and undetermined species of *Rhyncholophus* and *Holostaspis* as found in our collection. A species known as the *Eucharis-mite* (*Rhizoglyphus echinopus*) occurs on the diseased bulbs of the Easter Lily, and is supposed to be one of the causes of the disease. A mite

* Mr. Banks has determined all the mites and spiders in our collections.

parasitic on *Orthezia insignis* has been mentioned above (p. 806). Mr. Banks says it is a *Tyroglyphus*, but the specimens were too imperfect for specific determination.

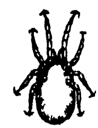
Orange Rust-mite. (*Phytoptus oleivorus* Ashm.) Fig. 225. This has been recorded as occurring on oranges in Bermuda, (see Riley and Howard, Insect Life, iii, p. 120, Nov., 1890.) It is a very minute species which causes the rusty patches on oranges.

224



224*a*

224*b*



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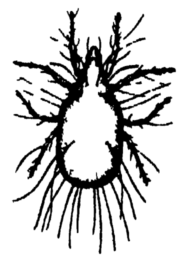

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Figure 224.—Cattle Tick (*Ixodes bovis* R.); after Riley. Figure 224*a* —Mange mite of cattle; after Murray. Figure 224*b*.—Bird-mite (*Dermanyssus avium*), after Murray. Figure 225.—Orange-rust Mite (*Phytoptus oleivorus*). Figure 226.—Cheese Mite (*Tyroglyphus siro*), after Howard. All much enlarged.

Cheese Mite. (*Tyroglyphus siro* (L.) Figure 226. This occurs in old cheese, as in Europe and the United States.

Tropic-bird Mite (*Alloptes phaëthontis* Gmel. (t. N. Banks.)

Several specimens of a small, dark brown mite, from .50 to .75^{mm} long, were found on the Tropic-bird by A. H. Verrill. The body is rather narrow, oblong, subacute at each end. Legs about half as long as body. Four caudal bristles, about as long as body.

Megninia æquinoctialis Trouess. (t. N. Banks.)

Associated with the above was a single specimen of this larger species, having the posterior legs much longer than the others; body ovate; abdomen tapered, subacute.

Leaf-mites; Red Spiders. (*Tetranychus.*) Two or more species of this genus were observed on garden plants, but were not carefully studied. The common form was, apparently, *T. bimaculatus* (fig. 227), common in the United States. This species usually has a red

or yellowish red body when mature, with a dark spot on each side, but sometimes it is greenish. Length of body, .4 to .5^{mm}. Lives under a loose fine web on the under side of leaves of various plants. Others were apparently *T. tilarius* (fig. 228), a common "red spider" of conservatories in Europe and America. It doubtless occurs here in abundance, at certain times. Both are very injurious.

A small, undetermined, yellowish white mite, probably of the genus *Uropoda*, was found strongly attached by a filament, in a cluster, on the posterior dorsal surface of the body of a *Pangæus*, a black cydnid bug (see fig. 175, p. 801). It has a short-elliptical body, convex above and flat below, with a chitinous integument; legs short. It is immature and probably undescribed, (t. N. Banks.)

Doubtless many more Acarina are common, but the mites have been very little studied here.*

227 228

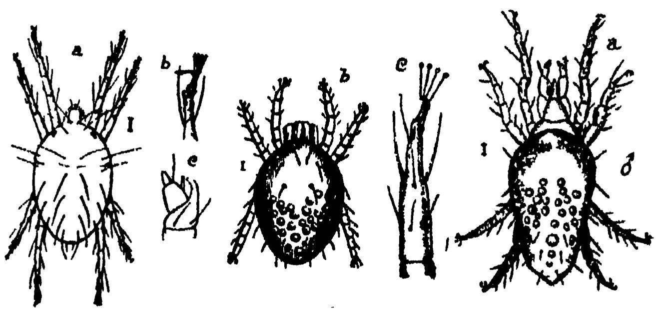

Figure 227.—Two-spotted Leaf-mite or Red-spider (*Tetranychus bimaculatus* Banks); *a*, dorsal view, ×86; *b*, tarsus and claw; *c*, palpus; after Banks.
Figure 228.—"Red Spider" (*T. tilarius* L.); *a*, dorsal view of male, ×40; *b*, six-legged young of same; *c*, tarsus and claw; after Murray.

c.—*Myriapods.* (Centipedes, etc.)

Only about seven or eight species of myriapods are known from the Bermudas, all of which, except perhaps the *Spirobolus*, have probably been introduced by man. The largest and most important is the Centipede.

Centipede. (*Scolopendra subspinipes* Leach.)

Plate C; Figures 1, 2.

This is common, at least in many parts of the Main Island, as at Bailey Bay and Walsingham. It is found under stones, old logs,

* The Mange-mite of cattle (fig. 224*a*); that of the horse (*Psoroptes equi*); and the Chicken-mite or Bird-mite (*Dermanyssus avium* Dug., fig. 224*b*) are known to occur.

etc. during the day. The larger individuals are about six inches long; color dark chestnut-brown, blending into dull verdigris-green on the sides. Although its bite is venomous and somewhat painful, as a member of my party experienced, it is scarcely more so than the sting of a large wasp or hornet.

Lithobius lapidicola Mein.

This European species was recorded, with some doubt, by C. H. Bollman, 1889, from Heilprin's collection. We found the same form rather common under stones.

House Centipede. (*Scutigera forceps* Raf. = *Cermatia forceps.*)

FIGURE 229.

Not uncommon in cellars, etc. It often gets into the water tanks. This is a harmless and very useful species, for it devours large numbers of flies, cockroaches, and other household insects. It is nocturnal in its habits, and runs with surprising agility at night. It is very

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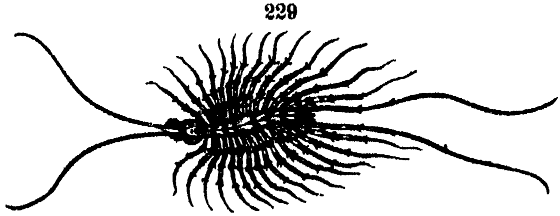

Figure 229.—House Centipede (*Scutigera forceps*); natural size, from Webster's International Dictionary; after Marlatt.

fond of moist places, like cellars and greenhouses. It is widely distributed and has become common in the seaports of southern New England during the past twenty years.

I found a specimen in one of the ancient water tanks at the ruined forts on Castle Island, long uninhabited. This would indicate that it was introduced here as long ago as the war of 1812.

Mecistocephalus Guildingii Newport.

A West Indian species recorded by Bollman, 1889.

Thousand-legs; Galley-worm; Milliped. (*Spirobolus Heilprini* Bollman.)

Described from Heilprin's Bermuda collection of 1888. We found it common under stones, etc. It is 2 to 2.5 inches long, round,

and rather slender, chestnut-brown, with reddish brown legs and antennæ; segments striated, except anteriorly, subsegmented.

Thousand-legs; Milliped. (*Julus Moreleti* Lucas.)

Recorded by Bollman, 1880. It is native of the Azores. Adults dark brown; legs reddish brown; young lighter, with a median black dorsal line, bordered with yellow, and with a row of black spots on each side. Common.

There are, apparently, other undetermined species of *Julus* in our collection.

Figure 229*a*.—Galley-worm, Milliped. (*Julus*, sp.)

39.—*Introduction of Terrestrial Isopod Crustacea.*

Eleven species of terrestrial Isopods are recorded by Miss Richardson* as in our Bermuda collections of 1898 and 1901. The following three new species are endemic, so far as known:

Porcellio parvicornis Rich., fig. 230; *Leptotrichus granulatus* Rich., fig. 231; *Uropodias Bermudensis* Rich. (gen. and sp. nov.).

Figure 232.—*a*, Sow-bug or Slater (*Porcellio lævis*); *b*, *b'*, Pill-bug (*Armadillidium vulgare*).

The following are widely distributed in both hemispheres and have doubtless been introduced by commerce.

Tylos Latreilli Aud. and Sav. (Sow-bug or Slater); *T. niveus* B. L.; *Porcellio lævis* Latr. (Sow-bug, Slater. Fig. 232, *a*); *Metoponorthus*

* Isopods of the Bermudas, Trans. Conn. Acad., xi, pp. 299–310, pl. xl, Jan., 1902.

sexfasciatus Budde-Lund; *M. pruinosus* Br.; *Armadillidium vulgare* Latr. (Pill-bug. Figs. 232, *b*, *b'*).

The *Actoniscus ellipticus* Harger is otherwise known only from New England.

The common bluish gray *Ligia Baudiniana* M. Edw., which runs very rapidly over the rocks, is found on all the sea-side ledges and cliffs and hides in their crevices. It is widely distributed in the West Indies and Tropical America. Figure 233.

Ligia oceanica, figure 234, probably also occurs, but we did not obtain it. Its distribution is world-wide in warm climates.

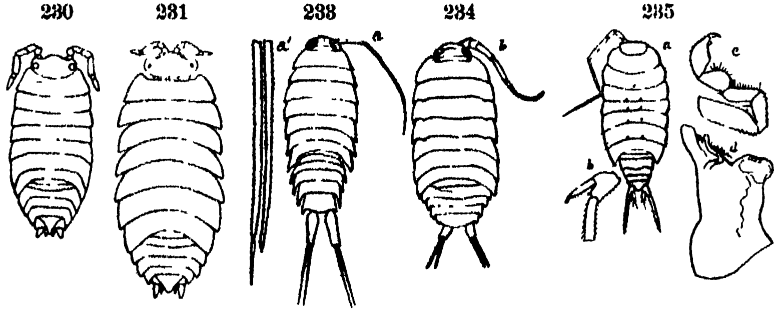

Figure 230.—*Porcellio parvicornis*; Figure 231.—*Leptotrichus granulatus*; enlarged; both after Miss Richardson. Figure 233.—*Ligia Baudiniana* × 1⅓; *a'*, uropodial spines. Figure 234.—*Ligia oceanica*, × 1⅓. Figure 235.—*Philoscia Bermudense* Dahl; *a*, × 8; *b*, uropodial spines; *c*, maxilliped; *d*, mandible; after Dahl.

Dr. Fr. Dahl (Plankton Exped., i, pt. 1, p. 111, pl. iii, figs. 2, 4, 5, 7, 8, 10, 13, 1892) recorded an additional species of terrestrial isopods, (*Philoscia Bermudensis*, sp. nov.) See figures 235, *a–c*.

40.—*Introduction of Earthworms; Land Nemerteans, etc.*

a.—Earthworms. (*Oligochæta.*)

Whether any earthworms were native to Bermuda is uncertain, though at least one species is not yet known from any other locality. The greater part of the common species have undoubtedly been introduced with the earth around growing plants. Several are well known European species, introduced also into North America.

The following species have been identified, from our collections, by Dr. J. Percy Moore, who has recently published a list of the species, with descriptions. (See Proc. Philad. Acad., liv, pp. 80–84, 2 cuts, April, 1902.)

Enchytræus marinus Moore, Proc. Phil. Acad., liv, p. 80, fig. 1, 1902.

White; common at and below high-tide mark, under stones, at Coney Island.

Eisenia fœtida (Sav.) Mich. Figure 236.

Easily recognized by its distinct bands of color. Upper side annulated with dark purplish brown or chocolate-brown, alternating with pale reddish brown or flesh-color; below light flesh-color, or pale yellowish; clitellus reddish or deep flesh-color, with the dark annulations less conspicuous or indistinct. Length 3–5 inches. Common under stones. A cosmopolitan species.

Figure 236.—*Eisenia fœtida; a*, mature, with clitellus developed; *b, c*, immature; nat. size; phot. from preserved specimens by A. H. V.

Pontodrilus arenæ Mich.

Light red or flesh-color, plain. Length, 3–4 inches. Common under stones at Elbow Bay and Hungry Bay, at and near high tide mark.

Helodrilus (*Allolobophora*) *chloroticus* (Sav.) Mich.

High-tide mark at Hungry Bay, in March and April, under stones.

Helodrilus, sp. A small immature specimen of a second species.

Eudrilus Eugeniæ (Kinb.) Mich.

A rather large species, 4 to 7 inches long; color dark reddish brown, with a bright purplish, iridescent luster. Under stones.

Pheretima Schmardæ (Horst.) Mich.

In formalin pale buff, with a purplish or chocolate-brown clitellus. In life, often dark brownish red or sometimes greenish or olivaceous. In formalin the segments are mostly carinate or angular, with long rows of hooks. It is a very lively species, and when disturbed wriggles about very actively, much like a salamander, and when caught often breaks itself into two or more pieces. New to Bermuda; known from Barbadoes.

Common under stones at the old Walsingham house.

Pheretima Rodericensis (Grubé) Mich.=*Perichæta Dyeri* Bedd.

A rather large species, 4–6 inches long. Color in formalin light yellowish brown; segments anteriorly and posteriorly with a prominent angular median carina, bearing long rows of hooks. Widely diffused in warm climates; West Indies. Active like the preceding.

Onychochæta Windlei Bedd. = *Diachæta Windlei* Bedd. Under stones, not common.

In addition to the above, Beddard has described, 1894, from this locality *Pheretima Bermudensis* Bedd., as *Perichæta*, which is widely diffused in the warmer parts of both hemispheres Also, 1891, *Pontodrillus Bermudensis* (?=*P. arenæ* Mich., t. Moore).

b.—Land Nemerteans.

A species of terrestrial nemertean (*Tetrastemma agricola* W. Suhm) was discovered in Bermuda by the Challenger Expedition.* We found it common under stones and logs, near Hungry Bay, not only close to the shore, but also on the hillsides where the soil was rather dry. It is said to live also in the holes of land crabs. Full-grown individuals are sometimes six inches long, in full extension, and very slender. It has four small but very distinct black eyes in a quadrangle. The color above is dusky brown, grayish, or smoky brown, paler below. See Plate C; figure 4.

Although it is known only from Bermuda, its habits and localized distribution are like those of a recently introduced species. It is associated with foreign species of earthworms and isopods; still it may, perhaps, prove to be endemic. We brought back living specimens in bottles of damp earth and mould without difficulty.

* See H. N. Moseley, Notes by a Naturalist on the Challenger, pp. 26, 27, and figure.

c.—*Land Planarians.*

FIGURE 237.

Mr. T. G. Gosling has sent me a brief description accompanied by a sketch of a peculiar worm that he found near Hamilton. It appears to be a land-planarian. The specimen was, unfortunately, not preserved. It was about six inches long in full extension; slender, its breadth about 3^{mm}; head flattened and semicircular, carried

Figure 237.—Land Planarian; dorsal view; × $1\frac{1}{2}$; after a sketch by Mr. Gosling.

somewhat raised while creeping. Body light brown, with three dark longitudinal stripes; head dark brown. Found July, 1901, at Norwood, in garden. See figure 237.

41.—*Introduction of Marine Species.*

We cannot doubt that many marine invertebrates have been accidentally introduced from North America and the West Indies, if not from Europe, while adhering to the bottoms of vessels, which in these waters soon become covered with firmly attached barnacles, mussels, hydroids, bryozoa, ascidians, etc.,* among which mollusks, crustaceans, annelids, etc., find congenial abodes and abundant food. Sometimes, after only a few months, the accumulation of such organisms may amount to many tons on a large vessel. Many of these creatures are discharging eggs or free-swimming embryos which can thus find their way to suitable localities on the shores or bottom. But we have no direct evidence as to which particular species have been introduced here in this way.

No doubt it would be easy, with suitable appliances and care, to introduce many useful or valuable species of fishes, shellfish, etc., from the West Indies and the southern United States. A vessel fitted with a live-well might be sufficient. Possibly the more valuable Florida sponges could be introduced in this way, and perhaps even the precious Red Coral of the Mediterranean.

* I was shown a good specimen of coral (*Oculina diffusa*), eight inches high, that had grown on the bottom of a vessel.

But it might be necessary to have suitable large stone receiving basins, with a circulation of pure sea-water, in which such things could be kept protected for a time, till they had opportunity to discharge one or two crops of eggs for the natural establishment of the species. The purity of the water here and the porosity of the rocks are exceedingly favorable for such experiments.

It seems possible, also, that the American Oyster (southern variety) could be made to thrive here in some of the brackish inlets, but it is useless to plant it in pure sea-water.

The Horse-shoe crab (*Limulus*) could doubtless be easily introduced, for it is tenacious of life and ranges from New England to Brazil. The large market crab of Charleston, S. C. (*Menippe mercenaria*) and other useful crustacea of that region could probably be easily introduced.

On a former page (p. 708) I have mentioned an attempt to introduce the West Indian Whelk (*Livona pica*). There is no reason why many other species should not be introduced, for there is plenty of food and pure water for a much richer fauna than now exists here.

BIBLIOGRAPHY.

As a very complete work on the Bibliography of the Bermudas is now in course of publication by Mr. George Watson Cole in the Bulletin of Bibliography,* it seems unnecessary to give in this place all the works referred to or quoted, and of which the titles have, also, in many cases, been given in foot-notes or synonymy. Therefore only the more important works will be given here, or those which students might often have occasion to consult. Mr. Cole's work has been of great value to me, in searching the literature of Bermuda. I am also indebted to him for the loan of several works on Bermuda, not otherwise available, and for revising the proofs of the following bibliography.

* *Cole, George Watson.*—Bermuda in periodical literature. A Bibliography. Bulletin of Bibliography The Boston Book Company, Boston. 8°. Vol. i (No 4, January, 1898), p. 52–54; (No. 5; April 1898), p. 74–76.

Note.—Three hundred and fifty copies separately printed. Boston, 1898.

Cole, George Watson.—Bermuda in periodical literature; with occasional references to other works. Series 2. Vol. ii, October, 1900, to vol. iii, No. 4, Jan., 1903. (Not yet completed. It will include the above, and be issued separately, with index, when finished.)

The titles of various works relating specially to the Geology and Marine Zoölogy are reserved for the succeeding parts, which are to be devoted to those subjects. But it is thought desirable to include here a list of the articles relating to the Marine Zoölogy of the Bermudas, recently published by this Academy.

General and Descriptive Works.

Anonymous.—A True Declaration of the estate of the Colonie in Virginia, etc. London, Wm. Barret, 4to, 1610. Reprinted by *Peter Force*, Coll., No. 1, vol. iii, 1844; and by Lefroy, Memorials, i, p. 12. Contains an account of the shipwreck of the Sea Venture and rescue of the people, pp 18–21 of Force's Reprint.

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Many of the volumes contain more or less matter relating to the marine zoology of the Bermudas. See *Cole, George Watson*, Bibliography, 1901 (this part also issued as author's separata), for full lists of such matter.

Godet, Theodore L., M.D.—Bermuda, its history, geology, climate, products, agriculture, commerce, and government. London. Smith, Elder & Co. 1860.

Note.—Those parts relating to Natural History are very inaccurate. Chapter xiv, "Shells," includes many East Indian species, and also Crustacea. See Addenda. But it contains much information on the government, agriculture, education, people, climate, etc., and especially in regard to the bad epidemic of yellow fever in 1856, during which Dr. Godet had medical charge of the "Thames," one of the infected hulks on which large numbers of convicts were confined. See pp. 24-32 of the book. Dr. Godet was a native of Bermuda.

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Jones, J. Matthew.—The Naturalist in Bermuda. London, 1859. Map.

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Note.—A large part of the descriptive matter in this work has been reprinted in Stark's Guide to Bermuda. It contains lists of birds, fishes, insects, shells, plants, etc.

Jones, J. Matthew.—U. S. National Museum, Bull. No. 25, pp. ix–xxiii, 1884.

Moseley, H. N.—Notes by a Naturalist on the Challenger. 8vo, London, 1879.

Note.—A number of pages are devoted to Bermuda, including an account of the geology (pp. 18–28), etc.

Ogilvy, John, M.D.—An Account of Bermuda, Past and Present. 64 pp., 8vo. Hamilton, Bermuda, S. Nelmes, 1883. Contains valuable matter relating to history, religion, education, climate, diseases, etc., especially yellow fever. Dr. Ogilvy was Surgeon-General of the post

Rich, R.—News from Virginia of the Happy Arrival of that Famous and Worthy knight, Sir Thomas Gates, etc., 1610. A poetical tract. Reprinted, in part, by Lefroy, Memorials, ii, p. 574.

Stafford, Richard.—Letter of 1668. Trans. Royal Soc., iii, p. 792. 1668. See above, p. 510.

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Note.—Statistical information about Bermuda is given as follows: 1828, English occupation; 1609, p. 60; 1829, Slave population, 4,608, p. 199; 1832, Population and trade statistics, p. 104–105; 1833, Rum imported from Bermuda, p. 183; 1834, Slaves; Education, pp. 180–181; 1835, Abolishment of slavery, p. 257; 1839, Slaves, 4,026, Appraised value, £175,194, p. 185. (Cole.)

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*Lefroy, Governor J. H.**—Memorials of the Discovery and Early Settlement of the Bermudas or Somers Islands, 1515–1685. Compiled from the Colonial Records and other original sources. London, Longmans, Green & Co., vol. i, 1877; vol. ii, 1879.

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Lefroy, Governor J. H. (Editor).—Historye [The] of the Bermudaes or Summer Islands, edited from a MS. in the Sloane Collection, British Museum, pp. 319, 8vo; with portrait of Capt. John Smith. Printed for the Hakluyt Society, London, 1882.

Note.—The author of this very important MS. History was supposed by Lefroy to have been Capt. John Smith. Subsequent investigations have shown that it was by Gov. Nathaniel Butler (1619–1622), and that Capt. Smith copied extensively from it in compiling his works. See "The Academy," Dec., 1892; also above, p. 552, note.

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* Governor Lefroy was the only governor of Bermuda actively interested in Natural History. He aided and encouraged the investigations of Mr. J. M. Jones; Mr. G. Brown Goode; Professor Wm. North Rice, and others. Governor Lefroy was heartily devoted to the interests of the Bermudas and promoted their prosperity in many ways. Many important public works were completed during his administration. He introduced large numbers of new, useful and ornamental trees and flowering plants, of which lists are given in his work on the Botany of the islands (Bull. U. S. National Mus., No. 25, 1884). See under Botany. He sailed from Bermuda, May 10, 1877. The farewell address by the Hon John Harvey Darrell, and Governor Lefroy's reply are printed in the Hamilton papers, May 15, 1877. He was the author of many works on Magnetic observations, Artillery, and other military subjects. He was born at Ashe, Hampshire, Jan. 28, 1817, and died in Cornwall, Eng., Apr. 11, 1890. See portrait, plate civ.

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Note.—At page 283 (original edition, p. 203) is found the earliest description of the discovery of Bermuda. This passage is quoted in full in *Lefroy's* Memorials of the Bermudas, vol. i, p. 2–3. (Cole.)

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Pegge, Samuel.—The question considered, whether England formerly produced any wine from grapes. Archæologia, vol. iii, pp. 53–66, 1775. Refers to the disappearance of orange trees and other fruit trees in Bermuda; attributed to the cutting of the sheltering cedars. Not seen.

Purchas.—See *Jourdan, S.* and *Strachy, Wm.*

Smith, Captain John.—The Generall Historie of Virginia, New-England, and the Summer Isles, 1624. Also editions of 1626, 1627, 1632. Reprinted by *Pinkerton, John*, Gen. Coll. of Voyages and Travels, London, 1808–14, vol. xiii, pp. 1–253, and in part by Lefroy. See our pl. ciii for portrait, and expl. pl. for historical data.

Smith, Captain John.—True Travels, Adventures, and Observations, in Europe, Asia, Affrica, and America ; 1593–1629. London, 1630. Reprinted by Churchill, A. and J., Coll. of Voyages, vol. ii (1704), pp. 371–412.

Note.—Chapter 22 : Summer Isles ; 1624–1629, pp. 401–402.

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Note.—The estimates of the age of this stalagmite that have been made, based on the subsequent growth of the stump, are utterly unreliable, for the conditions are, and have always been, exceedingly variable and diverse.

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Dana, James Dwight.—Corals and Coral Islands. New York, Dodd & Mead, 1872. (2d edition, 1874; 3d ed. 1890.) 8°. 398 pp.

Note.—Structure of the Bermuda Islands [with map], pp. 218–221; 218–226, ed. 3; former extent, p. 370; 408, ed. 3; caverns, p. 361; ed. 1, 2; p. 398, ed. 3. A list of corals, furnished by A. E. Verrill, comprising 17 species, is given on p. 114 [ed. 1, 2, 3].

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Jones, J. Matthew.—Geology of Bermuda. Bermuda Pocket Almanac, 1874, p. 58.

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Lefroy, Gov. John H.—Remarks on the Chemical Analyses of Samples of Soil from Bermuda. Addressed to the Board of Agriculture. Hamilton, Ber. 1873, pp. 1–46, with introductory remarks on climate and a meteorological table, pp. i, ii.

Murray, John, and *Renard, A. F.*—Report on Deep-Sea Deposits based on the specimens collected during the voyage of H. M. S. Challenger, in the years 1872 to 1876. 1890–91.

Stations at which dredgings were made at or near Bermuda were eighteen. The parts relating to Bermuda deposits outside and within the reefs, are on pp. 46–51, 54–55, 150–151, pl. 13; charts, 6, 8, 9.

Murray, John.—Summary of Scientific Results obtained at the sounding, dredging and trawling stations of H. M. S. Challenger. Part I, 1895.

The Challenger Expedition visited Bermuda twice; first, from April 3 to April 24, 1873; second, from May 28 to June 13, 1873. During the first visit 20 soundings were made at Stations 30 to 37 inclusive.

Nelson, Richard J.—On the Geology of the Bermudas. Trans. Geolog. Soc. London, 2d ser., v, pp. 103–123, with wood-cuts and map, 1837 (1840), based on observations made between 1827 and 1833.

Norwood, Richard.—Maps, 1626 and 1663. Reproduced in Lefroy, Memorials, vol. i, end; ii, p. 645. See above, pp. 535, note.

Norwood, Richard.—Letter, June, 1667, on tides, etc. Philosophical Trans. Royal Soc., ii, pp. 565–567, 1667. See above, p. 490.

Reid, Sir William.—An Attempt to develop the Law of Storms. London, 1838, 8vo. Contains a full account of the great hurricane of 1780, on pp. 311–367. 2d edition, 1841; 3d ed., 1850.

Reid, Sir William.—On the winds, as influencing the tracks sailed by Bermuda vessels, etc. Edinburgh New Philos. Journal, vol. xli (no. 81, July, 1846), pp. 192–194.

This article is dated at "Government House, Bermuda, 21st March, 1846," and contains observations on revolving gales and winds, with sailing directions

for vessels bound from Bermuda to New York; from New York to Bermuda; between Halifax and Bermuda; from Barbadoes or neighboring West India Islands to Bermuda; and from England to Bermuda. These directions were reprinted in several editions of Blunt's American Coast Pilot. Cole.

In the Library of Yale University are three volumes of unpublished correspondence between Gov. Reid and Mr. Wm. C. Redfield, mostly relating to meteorology. Refers to the sending of plows and many other implements, and many garden seeds, etc., in 1840–45.

Rice, Wm. North.—Geology of Bermuda. Bulletin United States Nat. Museum, No. 25, part i, pp. 5–32, with illustrations and a map, 1884. Reviewed in Amer. Jour. Science, ser. 3, xxix, p. 338, 1885, by J. D. Dana.

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Tarr, Ralph S.—Changes of Level in the Bermuda Islands. American Geologist, xix, pp. 293–303, plates 16–18, May, 1897.

Thomson, Sir C. Wyville.—Geological Peculiarities of the Bermudas. Nature, vol. viii, pp. 266, 267, 1 cut, July, 1873.

Thomson, Sir C. Wyville.—Voyage of the Challenger. The Atlantic, vol. 1. Chapter IV, with map. London, 1877; N. Y., 1878.

Tizard, T. H., and others.—Narrative af the cruise of H. M. S. Challenger, with a general account of the scientific results of the expedition. 2 vols in 3. 1882–1885 [vol. 1, 1884–85, vol. 2, 1882.]

Vol. i, pt. 1.—General description of the geology, flora, and fauna of the Bermudas; giving the movements of the members of the expedition, during their two visits, from April 3–23, and from May 28 to June 13, 1873; illustrated with 19 woodcuts, a diagram, and three charts, pp. 136–153, 160–167; other references to Bermuda, pp. 481, 483–484. See Cole, Bibliog. Chall. Exped.; and same issued as Separata.

Vol. i, pt. 2.—Revised table, showing the positions of the soundings, the temperature, etc., of surface and bottom water, trawlings, dredgings, etc., near Bermuda, Appendix II., pp. 1008–1009; report on the chronometers and the meridian distances obtained, while at Bermuda, Appendix III., pp. 1017–1026. The result obtained was as follows: Bermuda Island, Dockyard clock tower, 32° 19′ 4″ North Latitude, 64° 51′ 36″ West Longitude on chart, but by Challenger's observer 64° 49′ 24″ West Longitude, the meridian based upon Gibraltar and Halifax. Cole.

Vol. ii.—Abstract of magnetical observations taken at fifteen different points on land, at Bermuda, with descriptive references to observation spots, pp. 25, 46; pp. 56–59; Abstract of Variations, etc., pp. 76; 114–119; 274–276; 276–277; 278–279; 280–281; 296–297; 346–352; 364–369. Cole.

Verrill, Addison E.—Notes on the Geology of the Bermudas, Amer. Journ. Science, ser. 4, vol. ix, pp. 313–340, with 11 cuts and a map, May, 1900.

Medical.

Brainerd, John B.—Letter from Bermuda. Boston Medical and Surgical Journal. Boston. 8°. Vol. 118 (No. 16, April 19, 1888), p. 411–412.

Note.—Statistics of temperature for ten years give highest as 90°, lowest 42°. While it is no place for consumptives it is just the place for overworked and jaded men. Cole.

Donnelly, William.—Statistical and tabular returns on the diseases observed during three years [March, 1827, to July, 1830] on the coast of North America and at Bermuda in the West Indies Edinburgh Medical and Surgical Journal. Edinburgh. 8°. Vol. 39 (January, 1833), p. 1–19.

Note.—In addition to tabular returns of diseases, there is (p. 8) a Summary of Registers of the weather, temperature, etc., kept at Bermuda. Cole.

Godet, T. L., M.D.—See above.

Harvey, Christopher.—Endemic Fevers at Bermuda. British Medical Journal. London. 4°. Vol. 2 for 1890 (No. 1560, Nov. 22, 1890), p. 1172–1178. See above, p. 511. Reprint in Medical Progress, Louisville, Ky., v, p. 241, 1890.

Lefroy, Gov. J. H.—Sanitary Report of the Colony of Bermuda, Hamilton, 1872, folio, xx, 46 pp.

Matthews, H. E.—The Climate of Bermuda [from a medical point of view]. New York Med. Journal, vol. lv, p. 12, Jan., 1892.

Méricourt, A. Le Roy de.—Bermudes (en espagnol Bermudas, appelées aussi îles Somers). Dictionnaire encyclopédique des sciences médicales. Paris. 8°. Tome 9 (1868), pp. 168–177. Not seen.

Note.—There is also an edition bearing the date 1876. A short bibliography is appended to this article. Cole.

Ogilvy, John, M.D.—See above.

Botany; Agriculture.

Berkeley, Rev. M. J.—Enumeration of the Fungi collected during the exped. of H. M. S. Challenger. Journ. Linn. Soc., London, xiv, pp. 350–354. 1873. Enumerates 18 Bermuda species. Second notice, xv, pp. 48–58, 1876. Ten species · five new.

Bermuda Pocket Almanac for 1886, p. 197. Returns of Exports of the staple Productions for past 15 years. Produce shipped in 1885, pp. 146–150, with prices. Similar tables are printed in many later volumes.

Bishop, Geo. A.—The Diseases of the Lily in Bermuda, their cause, treatment, and prevention. Hamilton, 1898.

Cooke, M. C.—See *Hemsley*, below.

Crombie, J. M.—See *Hemsley*, and *Stirton*, below.

Darrell, R. D.; Wilkinson, W. H.; Hinson, H. J.—Onion Disease in Bermuda. Report to the Board of Agriculture, Dec., 1887. Reprinted in Bermuda Pocket Almanac for 1888, pp. 233, 234. Based on Shipley's report, below.

Dickie, George.—Marine Algæ of Bermuda. Linn. Soc. Journ., Botany, xiv, 1874, pp. 313–316 (44 species, 1 new); Supplement, vol. xv, 1877, pp. 486–489.

Grisebach, A. H. R.—Flora of the British West Indian Islands. London, 1864. Lovell Reeve & Co. Contains descriptions of most of the native and naturalized plants of Bermuda. Several species are recorded from Bermuda.

Hastings, General Russell.—Garden and Forest, iv, p. 511, 1891, on Potatoes; p. 452, 1891, on Onions.

Hemsley, Wm. B.—Challenger Expedition. Botany, part 1, vol. i. Report on the Botany of the Bermudas, vii + 135 pp., 18 plates. Accompanied by reports on the musci and other cryptogams, contributed, in part, by different authors. (*Crombie, J. M.*—Lichens; *Mitten, Wm.*,—Musci; *Cooke, M. C.*,—Fungi.)

Hemsley, Wm. B.—The Bermudas. Gardener's Chronicle, vol. xix, p. 367, March, 1883; p. 481, April, 1883; p. 656, May, 1883 (Bermuda cedar). See also articles in Journal of Botany, London, xxi, p. 104, (2 new sp.); xxi, p. 257 (Sloane coll.); xxii, p. 108.

Hinson, Dr. H. J.—Catalogue of Plants growing in Bermuda, both wild and cultivated. Bermuda P. Almanac, 1878, pp. 113–26; 1879, p. 114; 1881, p. 132. Enumerates 560 species.

Howe, M. A.—Botanizing in Bermuda. The Plant World, iv, pp. 101–4, June, 1901. Algæ, etc.

Hunter, Robert.—Bermudian Ferns. Journ. Bot., vi, p 367, 1877, (10 species).

Hurdis, John L.—On North Atlantic Storms. Proc. Nova Scotian Inst. Nat. Sci. i, part 4, pp. 140–146, 1867. Contains an account ot the great Hurricane of 1839, at Bermuda, and other storms.

Jones, J. Matthew.—On the Vegetation of the Bermudas. Proc. and Trans. Nova Scotian Inst., Halifax, iii, pp. 237–280, 1873. Enumerates 612 species.

Accompanied by Remarks on the Geology and Soil, which are reprinted in Bermuda Pocket Almanac, 1874, p. 58. See also Visitor's Guide.

Kean, Alexander L.—The Lily Disease in Bermuda. Botanical Gazette, xv, pp. 8–14, pl. i, 1890. Disease is attributed to a fungus (*Botrytis*) which is figured.

Kemp, Alexander F.—Notes on the Bermudas and their natural history, with special reference to their Marine Algæ. Canadian Naturalist and Geologist. Vol. 2 (No. 2, May 1857), pp. 145–156. See also, List of Marine Algæ, in *Jones, J. M.*, Visitor's Guide, pp. 149-151. Contains a list of 103 species by *Professor Kemp.*

Note.—Of marine algæ there are here catalogued about seventy species. Cole.

Lefroy, Gov. John H.—Botany of Bermuda. Bull. U. S. Nat. Mus. No. 25, pp. 33–141, 1884. Includes both wild and cultivated plants, with Introduction describing soil, climate, etc.

Millspaugh, Chas. Fred.—Plants collected in Bermuda, Porto Rico, St. Thomas, etc. Chicago. Field Columbia Mus. Publications, No. 43, 1900. Botan. Ser., vol. ii, No. 1, pp. 110, map. Publ. No. 50, No 2, pp 111–135, 1900.

Mitten, Wm.—The Musci and Hepaticæ collected by H N. Moseley. Linn. Soc. Journ., Botany, xv, pp. 59–73, 1876. Eleven species See *Hemsley*, above

Onion Disease.—Report on, to Board of Agriculture, 1887. See Bermuda Pocket Almanac, 1888, p. 233.

Moseley, Henry N.—On the marine Algæ of St. Thomas and the Bermudas. Journ. Linn. Soc., London, xiv, pp. 311–317, 1875. See *Hemsley*, above

Moseley, Henry N.—Notes on the vegetation of Bermuda. Op. cit. pp. 317–321.

Reade, Oswald A.—Additions to catal. of plants growing in Bermuda. Berm. P. Almanac, 1881, pp. 146–149. Adds 167 species to Hinson's list.

Rein, J. J.—Senckenberg. naturforsch. Gesellschaft Bericht, Frankfurt am Main, May, 1873, pp. 131–158. Includes a list of 109 species of marine algæ.

The same work, 1869–70, pp. 140–58, contains an article by Dr. Rein on the Coral Reefs, etc.

Shipley, Arthur E.—Onion Disease at Bermuda. Kew Royal Gardens, Bull. Miscell. Information, No. 10, London, 1887, pp. 28, 2 plates. Onion Thrips is recorded, p. 18. The disease is attributed to a parasitic fungus; remedies recommended.

Small, H. B.—Vegetation in the Bermudas. The Ottawa Naturalist, vol. xii, pp. 101–104; 109–114; 153–157, 1898.

Stirton, Dr. J.—Enumeration of the Lichens collected by H. N. Moseley. Journ. Linn. Soc., Botany, London, xiv, pp. 366–375, 1875. Enumerates 24 Bermuda species. These are revised by *Crombie, Rev. James M.*, in vol. xvi, pp. 211–217, 1877, who enumerates 29 Bermuda species. See *Hemsley*.

Woods, Albert F.—The Bermuda Lily Disease. Bulletin No 14, U. S. Depart of Agriculture, 15 pp., 4 figures, 1897, (see also Gardener's Chronicle, xxii, p 368, Nov., 1897, resumé of above).

Zoölogy: The Land Fauna. Mammals; Birds; Reptiles.

For additional bibliography of birds, see above, p. 725.

Amer. Ornith. Union Check-list, 11th Supl. The Auk, xix, pp. 315–42, Jl., 1902.

Anonymous.—Royal Soc. Phil. Trans., London, vol. i, p. 11; i, p. 132; iii, p. 792. Whale-fishery. See pp. 683, 684, above.

Cope, Edward D.—On the Reptilia of Sombrero and Bermuda. Proc. Acad. Nat. Science, Philadelphia, xiii, 1861, pp. 312–314. Contains description of the Bermuda lizard, sp. nov.

Denison, Lieut H.—Birds of Bermuda. Bermuda Pocket Almanac, 1876, p. 115. A list of 178 species, of which 117 are said to be in the collection of John T. Bartram. Reprinted 1877, p 97; 1878, p. 108 (181 sp.); 1879, p. 109, 1881, p. 127; (gives 183 species).

Dobson.—Catalogue of the Cheiroptera in the Coll. of the British Museum, 1878. Records specimens from Bermuda. See below, Addenda.

Garman, Samuel.—The Reptiles of Bermuda. Bulletin No. 25, U. S. Nat. Museum, pp. 285–303, 1884.

Note.—Contains full descriptions of the Bermuda Lizard and Sea-turtles.

Heilprin, A.—Bermuda Is. See above, Notes on birds are on pp. 81–88; Bats, p. 80; Insects by *Uhler, P. R.*, pp. 152–158; Spiders by *Marx, G.*, pp. 159–162.

Hurdis, John L.—Rough Notes and Memoranda relating to the Natural History of the Bermudas. Edited by H. J. Hurdis, from MS. notes, mostly made from 1847–1855, London, 1897.

Note.—This contains numerous observations, mostly in the form of a diary, concerning especially the birds, but including notes on mammals, insects, fishes, plants, etc. Mr. Hurdis resided in Bermuda 14 years.

Hurdis, John L.—Birds of Bermuda. B. Pocket Almanac, for 1851. See above, p. 725.

Jones, J. Matthew.—Mammals of Bermuda. Bull. U. S. Nat. Museum, No. 25, pp. 143–161, 1884. See also Naturalist in Bermuda, and Visitor's Guide to Bermuda, in list of General Works, above. Include lists of birds, fishes, etc.

Reid, Capt. Savile G.—The Birds of Bermuda. Bull. No. 25, U. S. Nat. Museum, 1884, pp. 163–279.

Note.—For other papers on birds by Reid, and also for papers on birds by Wm. Jardine; O. Bangs and T. S. Bradlee; D. W. Prentiss; A. K. Fisher; A. E. Verrill; A. H. Verrill, see above, p. 725.

Stone, Witmer.—Bermuda Birds, in *Heilprin, A.*, Bermuda Is., pp. 82–88, 1889.

Verrill, Addison E.—The Story of the Cahow, the mysterious extinct bird of the Bermudas. Popular Science Monthly, vol. lx, pp. 22-30, Nov., 1901.

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Waite, F. C.—Bufo agua in the Bermudas. Science, new ser., xiii, pp. 342-343, March, 1901.

Note.—Discusses the date of its introduction and its poisonous secretions.

Terrestrial Mollusks.

Aldrich, T. H.—Bermuda Shells. Nautilus, iii, No. 1, p. 9, 1889. Four species of Land-shells mentioned.

Bartram, John T.—Lists of Shells in the Bermuda Pocket Almanac, 1876, '78, '79. See above, p. 730, note.

Bland, Thos.—Geographical Distribution of the Genera and Species of Land Shells of the West India Islands. Annals Lyceum Nat. Hist. of New York, vii, p. 351, 1867. See also Jones, Visitor's Guide, p. 138, 139, containing the same list.

Cockerell, D. T. A.—Notes on Slugs. Journ. Malac., vol. vi, pp. 3-5, 1897.

Hastings, Gen. Russell.—The Broken-tail Snail in Bermuda; and Reply, by *Howard, L. O.* and *Riley, C. V.* Insect Life, iv, p. 334, 1892.

Jones, J. Matthew.—Cont. to the Nat. Hist. of the Bermudas. Part I. Mollusca. Proc. and Trans. Nova Scotian Inst., Halifax, vol. i, pt. 2, pp. 14-26, 1864. Includes 10 terrestrial species. See also Visitor's Guide, above.

Kobelt, W.—Die geographische Verbreitung der Mollusken, III. Die Inselfaunen. Siebenter Jahrgang (1880), Deutschen Malakozoologischen Gesellschaft der Jahrbucher. Frankfurt am Main, 8°, pp. 241-286.

Note.—The Mollusks of Bermuda are discussed on pp. 257-258 and a list of 20 species is given on p. 286.

Pilsbry, Henry A.—The Air-breathing Mollusks of the Bermudas. See below, p. 863. Includes all known up to 1900, and Bibliography. See also, *Heilprin, A.*, above, pp. 181-184; 191-201.

Prime, Temple.—List of Land Shells and Corals; 1852. Bermuda Pocket Almanac for 1853, p. 55.

Note.—Corresponds with the list in Jones' Naturalist in Bermuda, pp. 106-7, except that the latter adds two names to the list.

For *Five Essays* on the Spiral Snails of Bermuda, see above, p. 731, note.

Insects.

No descriptive works on Bermuda Insects, nor illustrations, have been hitherto published; those cited below are mostly mere lists.

Butler, Arthur G.—Lepidoptera collected during the Challenger Exped. Ann. and Magazine Nat. Hist., ser. 5, xiii, pp. 183-8, 1884. See pp. 781, 782, above; 9 species are enumerated.

Dahl, Fred.—Land-fauna of the Bermudas, Plankton Expedition, vol. i, part 1.

Note.—Includes a list of a few insects, spiders, land mollusca, isopods, etc. See pp. 749, 752, 755, 797, etc., above.

Geddes, G.—See above, pp. 763, 766, 782. Contains a brief list of Lepidoptera.

Godet, T. L.—See above, and Addenda.

Hinds, Warren E.—Cont. to a Monograph, Thysanoptera of N. Amer., Proc. U. S. Nat. Museum, xxvi, pp. 79–242, pl. i–xi, 1902. Contains detailed description, synonymy, and figures of the Onion Thrips (pp. 179–184, pl. vii, figs. 69–71).

Hurdis, J. L.—Rough Notes. See above, p. 850. Contains observations on insects, pp. 314–330, etc. See above, pp. 745, 755, 757, 764, 794.

Jones, J. M.—Visitor's Guide, 1876. See under General Works. Contains the fullest nominal list of insects hitherto published.

King, George B.—Two new Coccids from Bermuda. Psyche., vol. viii, p. 350, 1899.

Kirby, W. F.—See pp. 755, 828.

Saunders, Wm.—Insects Injurious to Fruits, pp. 436; 440 cuts. Lippincott & Co. Philadelphia, 1883. See above, p. 808, note.

Shipley, A. G.—Thrips on Onions. See under Botany, above.

Theobald, F. V.—Monograph of the Culicidæ of the World. Catal. Brit. Museum, i, p 28; ii, pp. 151, 358. See above, pp. 511, 746, 748, and Errata.

Riley, C. V. and *Howard, L. O.*, see above, pp. 742, 745.

Uhler, P. R.—Observations on the Insects of the Bermudas. Heilprin's Bermuda Islands, pp. 152–158, 1889. Contains a list of 15 species collected by Heilprin.

Verrill, Addison E.—[On Bermuda Scale-insects and remedies.] Royal Gazette, Hamilton, Dec. 16, 1902, p. 2. The Peach Fly in Bermuda. No. 1, Jan. 3, 1903, p. 2.

Arachnids and Myriapods.

Banks, Nathan.—Some Spiders and Mites from the Bermuda Islands, Jan., 1902. See below, p. 864.

Blackwall, John.—Notice of Several Species of Spiders. Annals and Mag. Nat. Hist., ser. 4, ii, pp. 403–10, 1868. Includes 6 species from Bermuda, 3 described as new.

Bollman, Chas. H.—Notes on a small Collection of Myriapods from the Bermuda Islands. Proc. Philad. Acad. Nat. Sci., xli, p. 127, 1889; reprinted in Heilprin, op. cit., pp. 162–165, 1889, and in Bull. U. S. Nat. Mus., No. 46, pp. 202–204, 1893. Contains 5 species, of which one is described as new.

Marx, George.—Contribution to the Knowledge of the Spider Fauna of the Bermuda Islands. Proc. Acad. Nat. Sci. Phil., xli, p. 98, 1889; reprinted in Heilprin's Bermuda Islands, pp. 159–162, plate 14, 1889.

Note.—Contains a list of 12 species collected by Heilprin, of which one (*Lycosa Atlantica*) is described as new.

McCook, Henry C.—American Spiders and their Spinning Work. Philadelphia, 1889–94, 3 vols. Numerous cuts and colored plates.

Terrestrial Isopods.

Dahl, Fred.—Land Fauna of Bermuda. Plankton Exped., vol. i, part 1, p. 111, plate iii, 1892. Describes *Philoscia Bermudensis*, sp. new, and figures *Ligia*, 2 sp. See above, p. 845.

Dollfus, A.—[Isopoda of the Challenger Exped.] Bull. Soc. d'Etudes Scientif., de Paris, xii, p. 1-8, pl. i, 1890.

Richardson, Harriet.—Marine and Terres. Isopods of the Bermudas. See below, p. 864.

Note.—Terrestrial Isopods, on pp. 299-308, pl. xl, includes 11 species, of which one genus and three species are new. See p. 844.

Earthworms and Nemerteans.

Beddard, Frank E.—Tail-bristles of a West Indian [Bermuda] Earthworm (*Urochæta ?=Onychochæta Windlei* B.; later). Nature, vol. xxxix, p. 15, 1888.

Beddard, Frank E.—Investigations into Structure of Oligochæta. Ann. and Mag. Nat. History, ser. 6, vii, pp. 88-96, 1891. Des. of *Pontodrillus Bermudensis*, sp. nov. (*?=P. arenæ* Mich., t. Moore)

*Beddard, Frank E.**—The Anatomy of a Species of *Diachæta*. Quart. Journ. Micro. Soc., 1890, pp. 159-171. *Diachæta Windlei* (=*Onychochæta Windlei*).

Beddard, Frank E—The Classification and Distribution of Earthworms. Proc. Roy. Phys. Soc Edinb., x, 235-290. *Perichæta aspergillum* Perrier, erroneously referred, and *Onychochæta Windlei*, p. 269.

Beddard, Frank E.—Ude-Beitrage zur Kenntniss auslandischer Regen-wurmer. Zeit. f. wiss. Zool, xliii (1892), pp. 57-75. *Eudrilus erudiens* (=*E. Eugeniæ* Kinberg).

Beddard, Frank E.—On the Species of the Genus *Perichæta*, Proc. Zoöl. Soc. London, 1894, pp. 153-172. *P. Bermudensis* described on pp. 160-3. (=*Pheretima Hawayana* (Rosa) Mich.)

Moore, J. Percy.—Some Bermuda Oligochæta, with a description of a new species. Proc. Philad. Acad. Science, liv, pp. 80-84, 2 cuts. April, 1902. See above. Records 9 species, of which 1 is new, from Yale Expeditions.

Moseley, H. N.—Notes by a Naturalist on the Challenger, pp. 26, 27, with cut. See above, p. 847.

Willemoes-Suhm, Rudolph von.—On a Land-Nemertean found in the Bermudas. Ann. and Mag. Nat. Hist., ser. 4, xiii, pp. 409-411, 1 pl., 1874. See also *Hubrecht, A. A. W.*, Voyage of the Challenger, Zoology, xix, pt. 54, pp. 23-25 and cut.

Natural History of the Bermudas; Articles in Trans. Connecticut Academy of Arts and Sciences, vols. x, xi, 1900-1902.†

1.—*Pilsbry, Henry Augustus.*—The air-breathing Mollusks of the Bermudas, vol. x (part 2, Sept., 1900), pp. 491-509. 1 plate.

Note.—Also issued separately. A general revision of all the known species of Bermuda land shells, with Bibliography.

* I am indebted to Mr. J. Percy Moore for the titles of several of Beddard's papers, and for synonymical notes.

† A limited number of copies of the separata of all the articles in this list can be obtained through A. E. Verrill, or the respective authors. For further information address A. E. Verrill, New Haven, Conn.

2.—*Garman, Samuel.*—Additions to the Ichthyological fauna of the Bermudas, from the collections of the Yale Expedition of 1898, vol. x (part 2, Sept., 1900), pp. 510–512.

3.—*Verrill, Addison E.* and *Bush, Katherine J.*—Additions to the marine Mollusca of the Bermudas, vol. x (part 2, Sept., 1900), p. 513–544. 3 plates.

4.—*Verrill, Addison E.*—The Nudibranchs and naked Tectibranchs of the Bermudas, vol. x (part 2, Sept., 1900), pp. 545–550. 1 plate.

Nos. 3, 4, were also issued, stitched together, as author's separata, Sept., 1900.

5.—*Verrill, Addison E.*—Additions to the Anthozoa and Hydrozoa of the Bermudas, vol. x (part 2, Sept., 1900), pp. 551–572. 3 plates.

6.—*Verrill, Addison E.*—Additions to the Crustacea and Pycnogonida of the Bermudas, vol. x (part 2, Sept., 1900), pp. 573–582. 1 plate.

7.—*Verrill, Addison E.*—Additions to the Echinoderms of the Bermudas, vol. x, (part 2, Sept., 1900), pp. 583–587.

8.—*Verrill, Addison E.*—Additions to the Tunicata and Molluscoidea of the Bermudas, vol. x (part 2, Oct., 1900), pp. 588–594. 4 figs. and 1 plate.

Nos. 5–8, were also issued, stitched together, as author's separata, Oct., 1900.

9.—*Verrill, Addison E.*—Additions to the Turbellaria, Nemertina, and Annelida of the Bermudas, with Revisions of some New England genera and species, vol. x (part 2, Nov. and Dec., 1900), pp. 595–672. 2 figs. and 1 plate.

10.—*Verrill, Addison E.*—Additions to the Fauna of the Bermudas from the Yale Expedition of 1901, with Notes on Other Species, vol. xi, pp. 15–62; plates i–ix; 6 cuts in text. Oct., 1901.

11.—*Verrill, Addison E.*—Variations and Nomenclature of Bermudian, West Indian, and Brazilian Reef Corals, with Notes on various Indo-Pacific Corals, vol. xi, pp. 63–168; plates x–xxxv; 8 cuts in text. Oct.-Dec., 1901.

12.—*Verrill, Addison E.*—Comparison of the Bermudian, West Indian, and Brazilian Coral Faunæ, vol. xi, pp. 169–206; 7 cuts in text. Dec., 1901.

Nos. 11 and 12 were issued, stitched together, as author's separata, Dec., 1901.

13.—*Banks, Nathan.*—Some Spiders and Mites from the Bermuda Islands, vol. xi, pp. 267–275, 3 cuts. Jan., 1902.

14.—*Richardson, Harriet.*—The Marine and Terrestrial Isopods of the Bermudas, with descriptions of new Genera and Species, vol. xi, pp. 277–310, plates xxxvii–xl. Jan., 1902. Also as author's separata.

15.—*Van Name, Willard G.*—The Ascidians of the Bermuda Islands, vol. xi, pp. 325–412, plates xlvi–lxiv. Jan. and Feb., 1902.

Also issued as author's separata, Feb., 1902.

16.—*Verrill, Addison E.*—The Bermuda Islands: Their Scenery, Climate, Productions, Physiography, Natural History, and Geology; with sketches of their Early History and the Changes Due to Man. Vol. xi. Part II, pp. i–viii; 413–956, including a full index of 44 pages; 285 cuts in text; 40 plates, lxv–civ. April, 1902—Feb., 1903.

Also issued separately, with new Title-page and special pagination [i–x; 1–544], as author's edition. Includes Bibliography, pp. 849–864.

Addenda.

Age of the Royal Palms. See pp. 424 ; 651.

The five Royal palms, east of Hamilton, were brought from Grenada about 70 years ago, according to Ogilvy, p. 36. It would be of much interest to know the age of other large palm and palmetto trees, but such information seems difficult to procure.

Age of the Tamarisk or "Spruce" Hedge, etc. See p. 433.

Ogilvy, p. 36, states that the old hedge along the North Road, near Hamilton, was planted by Governor Reid. In that case it would now be about 60 years old. The large Mahogany Tree, in the grounds of Archdeacon Tucker, at Flatts Village, is said to be about 60 years old.

Former Yellow Fever Epidemics. See pp. 511, 512, 516.

In addition to the epidemics recorded on p. 515, Dr. Ogilvy (Bermuda, Past and Present) records, as probably yellow fever, the epidemics of 1699 and of 1779–80. The latter, at least, seems very doubtful, for it originated as a "jail-fever" in the horribly filthy jail where American prisoners of war were confined. He also enumerates the epidemics of 1796, a "malignant type"; that of 1818 ; suspicious cases in 1820–22 ; that of 1837 ; and that of 1856.

Dr. Godet (Bermuda, its History, etc., 1860) gives many details of the epidemic of 1856, during which he had charge of the hulk "Thames," on which many convicts died. See below, p. 868.

No epidemic of this terrible disease has occurred here during many years past, owing undoubtedly to improved quarantine regulations and the more sanitary conditions prevailing on modern vessels. But it must not be forgotten that the recent discoveries in regard to the spread of this disease only by means of the yellow fever mosquito, also show how it is possible that infected mosquitoes might easily escape the usual vigilance of quarantine officials and thus introduce the disease. It has been proved that an infected mosquito incubates the disease germs about 12 days before its bite becomes dangerous to man. But in that time mosquitoes could easily travel, even on sailing vessels, in summer, from infected West Indian ports to Bermuda, and yet the vessel might have a clean bill of health. Therefore these recent discoveries indicate that even greater care should be taken to prevent the introduction of this disease than had been thought necessary previously, but in different ways. The old custom of disinfecting or destroying clothing, bedding, etc., and

allowing many infected deadly mosquitoes to fly away unharmed, was of very little direct value, except that the fumigations of vessels naturally killed any infected mosquitoes that still remained on board.

The old convict hulks, with their open tanks of rain water at hand for breeding the mosquitoes, were ideal places for the propagation of yellow fever mosquitoes to distribute the disease germs.*

The latest official reports from Havana claim that by following out the anti-mosquito method commenced there in 1901, not a single case of yellow fever had *originated* in that city during the year, from Sept., 1901, to Sept., 1902, inclusive.

Conspiracy of 1761–2. See p. 564. Add:

"A Valuation of certain Negro Conspirators Tryed, Convicted and Condemned by a Court holden pursuant to an Act of Assembly made by the said Court as follows :—

Natt, a Negro man Slave, late the property of Mr. Thomas Cox, deceased, Valued at	£70	0	0
Juan, a Negro man Slave, late the property of Joseph Pruden, Valued at	33	6	8
Peter, a Negro man Slave, late the property of Mr. Edward Parker, Valued at	91	0	0
Ben, a Negro man Slave, late the property of Mr. Elisha Pruden, Valued at	42	13	8
Mingo, a Negro man Slave, late the property of Richard Jennings, Esqr., Valued at	40	0	0
Nancy, a Negro woman Slave, late the property of Mr. Jonathan Tucker, Valued at	22	0	0
	£299	0	4"

January 20th, 1763.

Resolved that the said Valuation do pass this House."

Remarkable Rainfall, in July, 1886; Variations in different localities.† *See p. 495.*

"The rainfall last month was an extraordinary one. It was far in excess of any of which we have a record. The total rainfall was 18.62 inches, and it rained on 20 days out of the 31.

* It is of importance to note that Mr. L. Mowbray has sent to me a fresh specimen of the Yellow-fever Mosquito (t. Coquillett), taken at St. George's, Jan., 1903. See below.

† From the Royal Gazette, Aug. 3d and Aug. 17th, 1886, and Bermuda Pocket Almanac, 1887, p. 200.

In the rain record of 17 years the nearest approach to this quantity was in October, 1874, when the fall amounted to 16.50 inches. With that exception we have not, within the above period, ever registered as much as 12 inches in one month, except in November last, when the quantity marked was 12.48 inches.

Locality of Gauge.	Total Rainfall.	
Prospect Observatory	18 21	inches.
Station Hospital, Prospect	Same return.	
Public Grounds, Hamilton	17.05	inches.
Clermont, Paget	18.62	"
Government House, Mount Langton	18.05	"
Gibb's Hill, Lighthouse	9.42	"
Teucer Place, Somerset	11.38	"
Boaz Island, R.E. Office	19.90	"
St. George's, R.E. Office	12 188	"

The differences in the records are very remarkable over and above the fact that the average fall shows higher than any previous register during one month. The greatest amount registered during one day (24 hours) was on the 30th of the month: and the several returns for that day give the following widely varying results:—Prospect, 4.42; Hamilton, 1.19; Mount Langton, 1.64; Clermont, 1.67; Gibbs Hill, 1.54; Somerset, 3.6; Boaz, 6.35 (?); St. George's, 1.96.

Between the 1st and the 15th of the month the records vary from 2 inches (Mount Langton) 1.18 (Hamilton) 1.63 (Clermont) .51 (Gibbs' Hill) .90 (Boaz) .58 (St. Georges) to nil at Prospect and Somerset. At Clermont 3.15 was registered on the 28th against 3.02 at Hamilton and 1.90 at Mount Langton. At Prospect 2.50 was recorded on the 25th against only a very small amount in other localities. The average of the 8 registers taken shows a fall for the month of 15.60 inches." CAVENDISH BOYLE, *Reg. Genl.*

Registrar General's Office, Hamilton, Aug. 12, 1886.

Bats, p. 718. Add the following:

Two additional species of bats are recorded as from Bermuda, by Dobson. (Catal. of Cheir. in British Museum, 1878; see also Heilprin, Bermuda Is., p. 80.) But it seems to me more probable that the locality labels were erroneous, or that these bats were brought to Bermuda from the West Indies, after preservation, for no other examples have been observed. They are as follows:

Vampyre-bat (*Trachyops cirrhosus*). West Indies and South America.

Molossus rufus, var. *obscurus*. West Indies and South America, widely distributed.

*Zoölogy of Godet's Book.**

Dr. Godet's work contains much that is of interest and value concerning the agriculture, climate, government, education, etc. of Bermuda. The chapter on the yellow fever epidemic of 1856, during which he had charge of the patients on the convict hulk "Thames" is of particular interest, because based on personal observation and experience.

Dr. Godet was evidently not a naturalist and that portion relating to zoology is very unreliable and misleading. The zoölogical matter appears to have been put together very hastily, partly from memory, and partly compiled from foreign popular books. Perhaps the worst part of it is that section relating to "Shells," under which he included the Crustacea, Mollusca, and Tunicata. Among these he enumerated many common European, North American, and East Indian marine species, both of Crustacea and Mollusca, which are never found in Bermuda,† so that the lists are wholly unreliable.

At this time, however, it will only be necessary to discuss the terrestrial groups. As for the land Mollusca Mr. Pilsbry‡ has recently remarked that "The list might have been compiled in Bedlam, and is introduced here merely as a curiosity, and for the sake of bibliographic completeness."§

* *Godet, Theodore L., M.D.*—Bermuda, its history, geology, climate, products, agriculture, commerce and government. London. Smith, Elder & Co., 1860

† Among these falsely applied names of foreign Crustacea are *Lupa forceps; Cancer pagurus; Gelasimus vocans; Leucosia craniolaris; Maia squinado*, etc Among the foreign names of shells are *Buccinum undatum; B. lunatum; B. reticulatum, Purpura lapillus; Cassis rufa; Strombus gallus; Patella pellucida; Pecten concentricus; Venus gemma; Mya arenaria; M. truncata*, and many others.

Under "Corals," p. 244, he also enumerates various false species, such as *Alcyonium digitatum; Alcyonidium echinatum; A. gelatinosum; Fungia; Gorgonia verrucosa; G. placomus; G. lepadifera*, etc.

‡ Trans. Conn. Acad. Sci., vol. ii, p. 167.

§ "Under the head *Pulmonea* (pp. 224-227) are enumerated *Limax cinereus, Testacella haliotidea, Vitrina pellucida, Helix concava, H. hortensis, Pupa chrysalis, Clausilia papillaris, Bulimus lubricus, Achatina columaria, Succinea bermudiensis, Limnæa auricularia, Physa fontinalis, Auricula midæ*, and *Ancylus rivularis*. With the exception of *Succinea bermudiensis*, which is proposed as a new species, there is no reason to believe that any of these identifications were based upon Bermudian specimens" (Pilsbry).

However, the "*Pupa chrysalis*" may be the same as the "*Pupa*, an inch in length" recorded by Jones (Visitor's Guide, p. 89, 1876), as found by Rev. J. B. Freer, in 1861, near Gibb's Light.

How so many errors could have been made it is impossible to say, but some may have been due to superficial resemblances between certain Bermuda species and those figured in foreign works. Others may have been due to the fact that foreign shells are continually brought to Bermuda by sailors and disposed of as native species, even to this day. The lists of marine shells, etc., are quite as erroneous.

Godet's list of terrestrial mammals is peculiar. He names three "indigenous species" of the rat family. 1st, the "water-rat, *Mus amphibius*," "a little larger than the common rat" This is, without doubt, the common gray rat. 2d, "*Arvicola alliarius* Des." (4 inches long, ash-colored above, white beneath, ears large, almost naked). This is doubtless the common wood-rat See above, pp 712–717. 3d, "*Arvicola socialis* Des., *Mus gregarius* L.;" with "fur pale gray above, white underneath; ears short, broad, almost naked. About 2½ inches long; tail, 1 inch."

If the last were correctly described it would indicate a species not recognized by later writers. I suspect, however, that the description was copied from some book describing the original foreign *A. socialis*, and that the Bermuda mouse, so-called, was only the house-mouse, which often runs wild in the woods there. At any rate, no short-tailed mouse is now known in Bermuda.

The scientific names of the birds in his list (pp. 193–5) are often erroneous or badly misspelled, but the species can usually be determined by their common names. Thus the Cat-bird is called *Turdus merula*; the White-eyed Vireo, *Virco* [*Vireo*] *musicus*; the Tropic-bird, *Phæton Athenus* [*æthereus*]. No novel observations on the birds are given and his list might have been much improved had he consulted those of his colleagues who were collecting and studying the Bermuda birds at the same time, or the lists previously published.*

He mentions (p. 252) two species of lizards. One of these, called "*Scincus nasciatus* Holb." [*fasciatus*], is doubtless the well-known *Eumeces longirostris* Cope. (See above, pp. 697, 698.) The other, which he calls "*Scincus ocellatus* Da." is entirely problematical, for

* Lists of the birds had been published by Jardine, 1849, 1850; by Tristram, 1850; by Hurdis, in Bermuda P. Almanac, 1851. (See above, p. 725.) Hurdis and several others were collecting birds in Bermuda a number of years (1840–1855) before Godet's book was written. J. M. Jones collected there from 1855 to 1860, and later, and published his "Naturalist in Bermuda" in 1859, which, in Natural History, is far better than Godet's work. Why Godet did not utilize these available sources of information does not appear.

he gives no description. Perhaps it was only a color-variety of the preceding, which is variable in color. He says it buries itself in sand instantaneously, a habit that I have noticed in the common Bermuda lizard, when rocks are not available for its escape.

The chapter of 12 pages on *Entomology* (pp. 198–210) is mostly occupied with extracts from foreign elementary or popular books, describing the habits, structure, and classification of foreign insects. The species of real Bermuda insects, specifically named by the author, are but few, and to most of those he gave names that belong to very different foreign species, so that it is, in most cases, very uncertain to what particular insects he refers.

However, in some cases, he gives a few words of description or some original notes on habits that enable us to identify a few of his species with more or less certainty. See table below. Perhaps one or two of these are not included in my synopsis (e. g., *Anobium*, sp.).

According to his statements, insects were much more numerous, especially in mid-summer, than later collectors have recorded. But it must be remembered that, so far as known, no competent entomologist has ever made collections in Bermuda in mid-summer. Nearly all have collected only in winter or spring. The small summer collections have been made by inexperienced persons. The following extracts contain all that seems of any value on this subject:

"Among the riches of the Bermudian entomology, I have noticed among the species of butterflies, the *Pieris brassicæ,* the great garden butterfly, etc. The *Argynnis Paphia,* the *Heliconia,* and the *Nymphalis,* are common enough at all times, and in almost all situations. Others are abundant at a particular season or locality; but in general, butterflies are to be obtained only occasionally." . . .

"In the summer season, and more particularly on rainy nights, that section of nocturnal *Lepidoptera, Noctualites,* the *Pyralis,* the *Phalonites,* also that of the *Tineites,* etc., fly in at the open windows in great numbers, and speckle the ceiling or flutter around the glass shades with which the candles are protected from the draughts. A great number of small beetles and other insects also fly in on such occasions; and several interesting species may then be met with. But in general beetles and the other orders are extremely scarce, and especially *Diptera.* During the month of August the shrubs and trees that border the roads are alive with insects of all orders, but particularly *Coleoptera.* Many species of *Longicornes, Cassidariæ* (or tortoise beetles), *Chrysomelius, Coccinella* (or lady-birds), etc., occur by hundreds on the twigs and leaves; and the air is alive with butterflies, *Hymenoptera,* and *Diptera.*"

Species definitely recorded by Dr. Godet.

Godet's names of insects, etc.	Probable identity.
Pieris brassicæ, p. 198.	Pieris rapæ.
Argynnis paphia, p. 198.*	?
Heliconia, sp., p. 198.	?
Nymphalis, sp., p. 198.	?
Sphinx atropos, p. 199.†	Phlegothontius cingulatus.
Hepialus humuli (ghost-moth), p. 200.‡	?
Pulex penetrans (jigger), p. 206.	Sarcopsylla penetrans.
Anobium pertinax (death watch), p. 207.§	Anobium, sp. ?
Forficula auricularia, p. 208.‖	? Anisolabis maritima.
Blatta orientalis, p. 208.¶	? Periplaneta Australasiæ.
Blatta occidentalis, p. 208.**	? P. Americana.
Scorpio afer, p. 209.††	?
Tetragnatha extensa (silk spider), p. 209.	Nephila clavipes.

* No butterflies related to *Argynnis*, *Heliconia*, or *Nymphalis* are now known there. Probably they are only erroneous names for some of the most common species, which are not otherwise mentioned.

† "The caterpillar is of a very large size, and feeds on potatoes [?sweet], jasmine, etc." This remark indicates that it was the common Sweet potato Sphinx.

‡ "The great swift or ghost moth (*Hepialus humuli*) is a common insect, the male, with silvery white wings, and the female, buff with reddish marks." Nothing resembling this European moth has been recorded by any other writer.

§ "The death-watch *Anobium pertinax* is of a uniform brownish black color and is very common in our houses. The two sexes, in the season of love, have the habit of calling one another by beating with the mandibles on the wood-work." It is not stated whether this is from personal observation or not, but probably some species of *Anobium* does occur.

‖ Earwig, [? European] "ferruginous brown, shining, with a reddish head."

¶ Body deep brown, of a soft texture, head small, almost triangular, elytra and wings a little longer than the body." Wings of real *orientalis* are rudimentary.

** "A larger species of cockroach." Dimensions not given.

†† "The genus *Scorpio* (scorpions) furnishes a species known in these islands as the *Scorpio afer*. The body is blackish, with the joints of the feet and antennæ white. It grows sometimes to the length of four or five inches, but when they breed in houses they do not then attain above half the size before mentioned." The only modern record of a scorpion is mentioned above, p. 880, and below. The latter is a small, nearly plain brown species, quite different from Godet's description.

As Godet was a native of Bermuda, and also a physician, his observations on the "jigger" and its effects are of value. They indicate that it was formerly much more common than it is now, thus confirming the statements of Jones and of Hurdis:

"Among the Apterous insects we shall notice the jigger (*Pulex penetrans*). Its beak is of the length of its body; it introduces itself under the nails of the feet and hands, and the skin of the heel particularly; other parts of the feet and hands are also attacked by this insect, but not so frequently as the before-mentioned parts. No vigilance can prevent the attacks of the jigger; even the stockings and shoes of Europeans are not proof against the insidious assaults of this tiny flea; the very cleanest persons of the highest rank in society are obliged to have their feet examined regularly. The presence of a jigger beneath the skin, during the process of its gradual increase, commonly produces a titillation, rather pleasing than painful; but as no pain is felt till the sore is produced, the extreme laziness of the lower order of the blacks frequently makes them neglect the precaution of extracting them, till all kinds of dirt getting into the wound increases the difficulty of a cure, and sometimes the consequence is lameness for life.

The blacks, from mutual practice on each other, are quick at discovering, and skilful in extracting them. The operator begins with a short needle to open and widen the minute orifice in the cuticle, between which and the *cutis vera* (true skin), the swollen body of the pregnant female has taken its place; slowly and cautiously the depredator is exposed, until at length he removes the insect uninjured, without giving any pain, or drawing the least drop of blood." . . . "After the operation, a little grease and the ash of tobacco is rubbed into the empty cavity. There are two species of jigger, the white, and the green or poison jigger, both of which are very numerous and annoying."

Of Scale-insects, p. 203: "The bark of many of our trees appears often warty, by reason of small, oval or rounded bodies, like a shield or scale, which are fixed to them, and in which no external traces of the insect are to be observed."

Capture of Gunpowder from Bermuda, p. 456, note.

The following passages contain official references to this event, and the reciprocal action of Congress to relieve the destitution of the people of Bermuda, by sending provisions in return:

Pennsylvania—Committee [or *Council*] *of Safety. Minutes.* June 30, 1775, to November 12, 1776. Vol. x, p. 277–784. Harrisburg, 1852. 8vo

At the meeting of September 20, 1775, "Colo Dickinson, agreeable to a resolve of the Congress, applyed to this board for a state of the account of Powder between this board & the Congress, when he was furnished with the following account." In the account which follows appears the following credit entry: "Aug't 6.—By Sundry Casks of Powder imported in the Lady, Capt. Ord, from Bermuda, 1800 [lbs.]. . . . N. B.—There was upwards of 7 cwt of the powder imported from Bermuda that was not fit to use."—p. 340–341.

At the meeting of November 25, 1775, it was resolved to enter upon the minutes of the Committee the Resolves of Congress of the 22d November, 1775, for the relief of the Inhabitants of Bermuda, which was done. It was "Resolved, That this Board request the Committee of Inspection and observation to see the Resolve of Congress (inserted this day) carried into execution, granting permission to Edward Stiles to Load with Provisions the Sea Nymph, Samuel Stobel, Master, for Bermuda, p 411–414."—Cole, Bibliography.

Letter of Admiral George Somers. See pp. 541, 544.

The quaint letter of Admiral Somers, in regard to the wreck of the Sea Venture, the rescue of the people, and their arrival in Virginia, is remarkable for its conciseness, and for the absence of any reference to his own courageous efforts and personal hardships, which the other writers of his company speak of in the strongest terms.

It also gives a clear idea of the starving condition of the colonists at Jamestown, at that time, and his courageous attempt to reach Bermuda in his small pinnace to obtain provisions for them.

Sir George Somers to the Earl of Salisbury, June 20, 1610.*

Right Honorable

May yt please yo^r good honor to bee advertised that sithence our dep.ture out of England in goinge to Virginia about some 200 leagues from the Bermoodas wee weare taken with a verie greate storme or hurricane which sundred all the fleete & on S^t Jame's daye beinge the 23 of Julie wee had such a leake in our ship insomuch that there was in her 9 ffoote of water before wee knewe of any such thinge wee pumped with ij pumpes and bailed in iij or iiij places with certaine Barrackoos & and then wee kept 100 men alwaies workinge night and daie from the 23rd vntill the 28th of the same Julie being ffridaie (at w^ch time) wee sawe the Iland of Bermuda, wheare our ship liethe vpon the rocke, a quarter of a mile distant from the shoare wheare wee saved all our liues & afterwards saued much of our goodes, but all our bread was wet & lost. We continewed in this Iland from the 28th Julie vntill the 10 of Maie In w^ch time we built ij small Barkes to carrie our people to Virginia which in number whare 140 men & woemen at the coming to the Iland Wee dep.ted from the Bermuda the 12

* MS., Colonial, 1574–1611, vol. i.

of Maie & arived in Virginia the 23rd of the same monethe and cominge to Cape Henrie the Captaine theare tould vs of the ffamen that was at James Towne whereupon wee hastened vp there and found yt true ffor they had eaten all the quick thinge that weare theare & some of them had eaten snakes or adders But by the industrie of our Governor in the Bermooda (Sir Thomas Gates) thear was saued a litell meale: ffor our allowance would not extende to aboue one pownde & a halfe ffor a man a weeke and this wth ffishe wee liued & this allowance 9 monethes our Govern^{r} Sir Thomas Gates did allowe them as wee had with some Porke & recovered all savinge iij that did die & weare past recou^{r}ie before our cominge* Wee consulted together what course wear best to bee taken ffor our meanes would not continue aboue 14 daies Wee thought good to take into our iiij pinaces as much of the municon as wee could & tooke in all the people & weare goinge downe the River but by the waie wee met wth the Lorde Laware [Delaware] & Lord Governor which made our heartes verie glad & wee p sently returned vp to James towne & theare wee found noe salvages for they weare affraid to come thither for they did not trade wth our men these manie monethes The Trothe is they had nothing to trade withal but mulberries Nowe wee are in a good hope to plant & abide heere ffor heere is a good course taken & a greater care than ever thear was I ame goeinge to the Bermooda for ffishe & hogges with ij small Pinaces & ame in a good opinion to bee back againe before the Indians doe gather their harvest The Bermooda is the most plentifull place that ever I came to, for ffishe Hogges and ffowle Thus wishinge all healthe with the increase of honor doe humblie take my leave ffrom Virginia the xxth of June 1610

Yr honors to comand

GEORGE SOMERS

ffrom James Towne in Virginia

"How great the exertions were by which Sir George Somers was mainly instrumental in saving the lives of all his companions in shipwreck would never have been gathered from his own report, and we must turn to their narratives to appreciate them rightly."—Lefroy. (See extracts from Narrative of Strachy, pp. 537–545, above.)

Punishment of Crimes (pp. 447, 550, 556, 560–64, 570).

In order to illustrate more fully the ideas and customs of the early settlers, a few additional records of trials and sentences for crimes are here inserted.

After the advent of Governor Butler, in 1619, courts and a local legislative body were regularly established. Trials by jury had commenced at least as early as 1618, under Governor Tucker, but they were neither regular in form nor strictly legal, for the English laws should have fully applied here at that time.

* A contemporary writer states that in four days more all would have died of starvation.

However, it is evident that no very just trials could have been expected, even under the subsequent English system, for the jurors and witnesses were usually very ignorant and superstitious, and easily influenced by the opinion of the governor and other officials. Moreover, no counsel was employed for the defence, and rarely, if ever, was a witness called for the defendant, though the accused party could make a statement in defence or deny charges, but such denials carried very little weight.

Witnesses for the prosecution were not cross-questioned and the most absurd and frivolous stories, gossip, and hearsay scandals were allowed full weight, even in capital cases, especially in the witchcraft trials. It is sufficiently evident from the records that the witnesses were often actuated by malice or revenge,—indeed in some cases this was afterwards confessed. In some cases testimony of convicted criminals seems to have been allowed as much weight as that of honest persons. A person accused of a crime, before a "grand jury," was almost always assumed to be guilty, and was convicted, unless he could prove his innocence,—a thing often absolutely impossible, as, for instance, in the witchcraft cases, when the presence of a wart or mole on the body was considered absolute proof of the crime.

The earliest governors were about as jealous of their dignity as is the present Emperor of Germany.

The earliest trial and execution under Gov. Tucker was that of a Frenchman, John Wood, in 1616, for using disrespectful language to the Governor, while drunk.

Governor Butler's account of this trial is as follows:

"Presently after this pinnace's departure, began the assize at St. George's, wher (fewe matters of note being handled besides) ther was arraigned and condemned by a jury of twelve men (but in a disorderly form, mixt betwixt martiall lawe and the lawes of England) which defaced them both, one John Wood, a poore but desperate and open-mouthed Frenchman, who, in his cupps, haveing saucely and arrogantly spoken to the Governor, was hereupon attached; and being endicted of mutiny and rebellion, upon his triall was cast; and so being sentenced by one deputed to that purpose (for the Governor himselfe, findinge his insufficiencyes that way, never satt judge in his owne person) was publicly hanged within two dayes after, choyce being made of the person of that poore man to lett the rest knowe that both his authoritie extended to life, and that they should all of them take heed how they provoked him hereafter; and indeed from that time forward it was observed that he overfast declined to such a height of severitie towards all men as wanted but very little of crueltye and tyranny; so that he hath bin seene, in one morneinge before breakefast to cudgell with his owne hands not fewer than fortie of his poore workmen, even for very smale and slight neglects."

The next year a woman was tried for criticising this trial and execution, and was sentenced to be hanged, but was finally reprieved by the Governor "in his great mercye," and remained a "condemned person," and perhaps a "slave to the company," which was the usual mercy shown in such cases at that time.

According to Gov. Lefroy:

"The trial of Nicholas Gabriell, labourer, of Pembroke tribe, [May, 1617] is partly legible. 'He was sentanced to be hanged' as Smith says, 'for concealing some speeches Mr. Pollard and Mr. Rich should use, tending to the disreputation of the Governour and his injustice and cruelities, and it appears that when he was brought unto the place of execution, the hangman not yet having done his worke, the Governor in mercy granted a reprive and did sentance him to be a slave unto the colony until by his good behaviour he should deserve a free pardon from him.'"

But Gov. Butler remarks that this was an "irregular and unwarrantable condition, contrary to the laws and customs of England."

Disrespect toward other officials was also punished:

"Att a Councell Table held the 6th day of September, 1627:

Nicholas Jones of Hambleton Tribe (for saying he was as good a man as Mr Devenish although hee was one of the Governers counsell) was censured to bee laid necke and heeles togeather for one hour upon the wharfe at St. Georges near the pillorie, with this inscription written over his head: FOR SLIGHTING, CONTEMNING, AND COMPARING HIMSELFE WITH THE GOVERNOURS COUNSELL."

Governor Butler, in 1622, according to his History, had a much more serious case of seditious and mutinous language, for which Thos. Harriot was tried and convicted:

"Hereupon, accordinge to these profes. and confessions, a censure passed upon him by the Governour and Counsell, sittinge publickly in Court, the which with a very unusuall unanimitie was as followeth:—

"That he, the sayd Thomas Harriott, their prisoner at the barre, being accused and convicted of all the turbulent behavior and seditious speeches conteyned in the articles aforesayd, should be conveyed manacled quite through the maine unto Southampton Tribe (wher he had acted the most part of his insolencyes and mutinys) ther to have one of his ears nayled to a whippinge post (which was purposely to be erected and called Harriotts Post) soe to stande the space of halfe a houre, then to be brought back to the towne of St. Georges, and in the pillory ther to lose his other eare; to pay a fine of one thousand poundes of tobacco to the use of the Honourable Company, and to remaine a prisonnour in the gayle of St. Georges dureinge the sayd Companyes pleasure."

"The which sentence was shortly after executed upon him, only in pity and commiseration the Governor spared him one of his eares, upon his future good behavior, haveing bin also very favourably used in the takeing away only of a peece of the other."

A stringent law against gambling was passed in 1623.

At the Assizes held 17–19th July, 1627, the following sentences were imposed for theft:

"Richard Strond late of Smiths Tribe, labourer, Indicted for that hee, the said Richard, about the second day of may last past, 1627, by force and arms into the House or Cabben of Richard Huet of Smiths Tribe aforesaid did enter, and then and there beeing did felloniously take, steale and carrie awaie 6 lb of corne, price 12d, of the goods and chattels of Richard Huet aforesaid, contrary to the peace of our soveraign Lord the king his crowne and dignitie.

Of wch indictment The said Richard Stroud confessed himselfe guiltie, for wch he was adjudged to receive 20 lashes upon his naked backe, which was performed the 20 July, 1627."

"Jerome Edes received the like sentence and punishment for stealing three shirts price xiid, off a Pumpian vine, the goods and chattels of John Birch."

"William Hingson, alias fatt, was convicted of stealing from a cabin 1 pair of shoes price five shillings, upon which he having beene so oft pardoned before, did now receive the sentance of death which was executed upon him the 21st July, 1627."

Blasphemy or swearing appears to have been very prevalent among the early settlers, and, in extreme cases, was sometimes punished, but probably only a few of the convictions are recorded:

Thus in July, 1627:

"Robert Newman being complayned of and presented for an horrible swearer and curser and having no meanes to pay the fine according to the statute in that case provided, was adjudged to receive 20 lashes upon the naked backe as punishment for his said offence, which hee suffered accordingly."

"Extract from a Presentment of the Grand Jury to a Court of Assizes held in St. Georges, November, 1659.

The Grand Inquest did present John Morgan, Chirurgian, for speaking of most Blasphemous words against Almighty God as per the attestations of Elizabeth, the wife of Josias Newman, Samuel Dunscome, Thomas Hartlan, and Louis his wife, and Francis Welch do more at large appear, for which Blasphemous words he was censured.

By the Secretary and the major part of the Council, to lie in prison, according to the Statute, three months, or to give 10lb Sterl: for the public works.

Mr Richard Norwood's censure, that he shall stand upon the Pillory, and be burned through the tongue with an hot iron, and to practice no more in this Island. Capt. Tho. Richards that he shall be forthwith banished."

In many trials different persons were allowed to express their opinions as to the punishment, as in the above instance. Frequently the punishments suggested were extremely cruel and barbarous. Mr. Norwood was probably the best educated man on the islands at this time. He was the distinguised engineer or surveyor of the islands and taught the principal school for many years. But he was a very religious man and a zealous churchman, to whom blasphemy was one of the worst of crimes.

Perjury, which is seldom mentioned in the records, was sometimes punished :

"Assizes at St. Georges, ending 1 March, 1618."

"Robert Hall was indicted of insolent perjurye 'for that thou has taken thie corporal othe falsely econtrarye to the lawes of Almightye God' of which he was found guiltie Soe sentance passed upon him to have both his eares cutt of close by his head, but the Governor in hope of his amendment of life, did mitigate his punishment, soe the third of March, 1618, his lefte eare was cutt of."

Witchcraft Trials.

In 1623, the church wardens and sidesmen were directed to present offenders for various crimes, such as heresy, going to irregular churches, absence from church, joining the Brownists, swearing, Sabbath-breaking, quarrelling, drunkenness, wife-beating, cruelty to servants, usury, etc., and against "all Sorcerers, Inchanters, Charmers, Witches, Figure-casters, or Fortune-tellers, Conjurers, or whosoever hath or seemeth to have any familiar consultation with the Devill."

However, there are no trials for witchcraft recorded until after the appointment of Governor Forster, in 1652. Most of the trials of this kind, and all the recorded executions for witchcraft, took place during his term of 6 years. He seems to have been personally zealous in this matter, but he was aided and abetted by the Puritan party, which had much increased about that time.* The names of prominent leaders of that party appear in the records of the trials, as in the witchcraft craze at Salem, Mass., about forty years later. But the clergymen of Bermuda took no active or conspicuous part in the persecutions there, nor do their names appear in any of the trials. It seems to have been regarded here as a strictly criminal matter, to be dealt with by the courts, like ordinary crimes.†

The prevailing ideas and superstitions relating to witchcraft are

* It will be remembered that at and before that time a vastly extended epidemic of witchcraft persecution had spread over England and Scotland, Germany, and other parts of Europe. It is said that over 8,000 executions for witchcraft took place in England during the Long Parliament, besides many thousands before and subsequent to that event. Thousands were also executed. at about the same time, in Europe. It is not to be wondered at that a slight ramification of this craze reached Bermuda. No doubt the witchcraft doctrines and the modes of detecting witches, then current in England, had often been expounded in Bermuda pulpits, which would account for the marked similarity in the trials and testimony.

† Many of the minor details of these trials are here omitted, only the more essential parts being given, or else those details that best illustrate the superstitious beliefs of the time. For fuller details and additional trials see Lefroy, Archeolog. Jour., xxiii, pp. 99, 239, 1876; and Memorials, vol. ii, pp. 601–33.

shown, to a considerable extent, by the records of the trials and of the kinds of testimony then allowed as evidence, most of which was utterly puerile and worthless. Some of the victims seem to have been scarcely half-witted ; others were the victims of malice and spite, or of the secret calumnies circulated as gossip in a neighborhood, just as often happens in "society" nowadays. Some of the witnesses naïvely stated that after quarreling they had threatened to accuse a neighbor of witchcraft, if any illness or misfortune should later happen to them. In at least one case such a quarrel and revenge led to a conviction and execution, in spite of this admission.

The ordeal by water was used in Bermuda in at least two instances, given below, and very likely in other cases not recorded, for the records of this particular period are imperfect. The crucial test, however, in all cases, was the presence or absence of moles or warts, supposed to be the "teats that the impyes do suck."*

The following is the first of the witchcraft trials :

"An assize and generall Goale deliverie held at St Georges from the nineteenth daye of Maye to the 22nd daye of the same month, 1651. Capt. Josias Forster Governor, &c.

(1) The Jury for our Soveraigne Lord the kinge Doe present Jeane Gardiner the wife of Ralph Gardiner of Hambleton tribe for that ye said on or about the 11th day of April 1651 feloneously deliberately and malliciously did saye that she would crampe Tomasin, a mulatto woman, in the same tribe, and used many other threatenninge words tending to the hurt and injurie of the said mulatto woman, and within a while after by practice and combinason with the devil, fellonously did practice on the said mulatto the diabolicall craft of witheraft, insoemuch that the said mulatto was very much tormented, and struck blind and dumb for the space of twoe houres or thereabouts, and at divers tymes in other places did practice the said devilish craft of witchcraft on severall persons to the hurt and damage of their bodyes and goods, Contrary to the peace of our Souveraigne lord the Kinge his crowne and dignitie.

To which indictment she pleaded not guilty, but beinge the grand inquest found a trewe bill and for her further triall did put herselfe uppon God and the Countrey, which beinge a jury of twelve sworne men did find her guiltie, whereupon the sentence of death was pronounced upon her, and accordingly she was executed on Monday the 26th day of this instant May, at St Georges, before many spectators."

(2) "The proceedinge against this woman was longe and teadious, by reason of many acusacons. The Governor and counsell was very carefull in findinge out the treweth. They caused a jury of woemen to search her and one Goody Bowen which was suspected: they returned as followeth. Havinge made diligent

* This absurd superstition, like most of the others connected with witchcraft, was held in accordance with the prevailing theological teachings and books of that period, both Protestant and Roman Catholic. The works of Matthew Hopkins, as is well-known, were especially prominent in spreading such fatal absurdities, but the same doctrines had been previously promulgated in several papal bulls, 1484 to 1522, and in various works of eminent Roman Catholic writers.

searche accordinge to our oathes we cannot find any outwards or innwards mark soe far as wee can p.oeave whereby wee can in conscience find them or either of them guilty of witchcraft, onely in the mouth of Goody Gardiner there is a blewe spott which being prickt did not bleed and the place was insensible, but being prickt close by it, it bled the which wee leave to the judgment of Phisitians. Mr Hooper and the chirurgions being appointed to viewe that spott, the daye that she was come to her triall, and it was fallen away and flatt, and being prickt it bled and it was knowne to be there 18 yeares, and for further triall she was tried and throwne twice in the sea. She did swyme like a corke and could not sinke. These signes and other strong evidences in Court condemme her, yet neverthelesse shee would confesse noething att her death She was demanded in Court if she could give a reason why she did not sinke. She answered that she did open her mouth and breathe but could not sinke."

2. *Trial of John Middleton, 1653.*

"(10) The examination of Robert Priestly, taken before Mr. Stephen Paynter and Mr Wilkinson, Councell, April the 17, 1653"

"Who saith that on Fryday last, being the 15th of this instant, he being removeing Mr Tucker's cattell in the evening in a peece of ground near to the house of John Midleton, he saw right ŏppositt agt the house, a Black creatuer lye soe upon the ground (sic) in the shape of a catt but farre Bigger, with eyes like fier, and a tayle near as long as a mans arme, And this examynate being some whitt daunted at the first sight, yet tooke courage & went upp close to yt to look on yt. he only saw it move the head, and drawne his knife with a resolution to stabb yt: as he lift up his hand and knife to strike at yt with all his force, he being a strong man, he found he had no power to strike it. Att which this examinate was so amazed and affrighted that his hayre stood up right on his head, and he departeing from yt looked backe, & sawe the said creature turne the head and look wishfully after this examt, but he ran away & left yt: reporting the same to the servant in his house, with much feare.* And further saith not. (Signed), ROBERT PRIESTLY.

"(5) Upon these and many clear grounds of suspition of John Midleton being guilty of witchcraft, Captain Josias Fforster, Gevnor, appoynted the severall men to search Midleton which follow:" (names of 6 men are partly legible). "who made report as ff'th, And do affirm that upon the search of Midleton's body they stretched out his body upon a chest And thereupon discovered first one teate or dugge about the biggness of a catt's or bigger, which teate or dugge was moyste & they say that Midleton confest that the moystner yssued from that Teate. They affirm further that right over against that said Teat or dugg, they found another yet not altogether so bigg or great as the other, which had no sign of moystuer at present. They further affirm that they found on his body divers suspitions markes & spots, Blew in culler. They say further that because they desired to be better satisfied amongst themselfes they concluded to search each other, to see whether there might appear any such markes upon any of themselves, which they did accordingly, but they affirm that they found not any, nor the likelyhood of any."

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* Apparitions of the devil in human form are not mentioned here, and "spectral apparitions" of the "witches," so prominent in the Salem trials, were more seldom asserted here. But the "black-cat" superstition was believed in.

(8) "Thom. Hess and Michel Burrowes, exam. before the court for the Triall of John Makaraton [Middleton], the 4th of May."

"Who saith that after Midleton came out of the water and was taken backe to prison, they being there with him, asked what he could now saye for himself; seeing he had ben also tried by water, desierd him to confes the truth to them, & they doe both say that Midleton told them that he was a witch & that he knew yt not before: they affirmed also that they did ernestly perswade Midleton to discover other witches if he knew of any in these Islands. To which he answered that the wife of Thomas Stevenson was a witch, as badd a one as any in the world. And said also that Goody North was a witch he feared, but did not positively accuse her to be a witch."

"The Jury for the keeper of the Commonwealth of England doth present John Midleton of Sandys Tribe in the Somer Islands, Planter, for that he not having the feare of God before his eyes hath feloniously wickedly and abominably consulted and consented to and with the Devill to become a witch. As doth appear by severall signes and markes upon his Body, and that diabolicall sin of witchcraft hath put in practice now lately upon the Body or person of John Makaraton, a skotsman of about the age of 50 years: and him hath vexed tormented and disquieted contrary to the peace of the Commonwealth of England and the dignity thereof.

This Bill being put to the consideration of the Grand Inquest was found *Billa vera* and for his further triall he put himselfe upon God & the Country, whereof a jury of 12 men sworne did find him guilty, and sentance of death was pronounced upon him, and he was executed at Georges towne at the common place of execution the 9th of May 1653."

3. *Trial of Goody Christian Stevenson, 1653.*

Middleton having accused Goody Stevenson of being a witch, was required to make his accusation in her presence in open court, which he did.* She stoutly denied any knowledge whatever of anything of the kind.

(13) "Then Midleton said, I 'thought that a man could not do the thinges I was accused for, & prayed that God would show his judgement upon me as you do. But since I came to prison I prayed to the Lord to discover yt to me, and now he hath found me out, & made me know that I was a witch, which I knew not before: & said I bless God for yt.' Goody Stevenson replied that she for her part was wrongfully accused for she knew nothing that did belong to any such thing. John Midleton said unto her 'I know that you are a witch as well as I' & said, 'perceiving that you are a witch I would have thee judged.'

"The examynation of Christian Stevenson taken before Captn Josias Fforster Govnor, Captn Roger Wood and the Secretary the 9th of Maye, 1653.

(1) Christian Stevenson having been accused in open court by John Midleton to be a witch: and she being now examined: she denyeth it & saith that she is noe witch: yt being then demanded of her how she came by the duggs & markes

* Other testimonies, here omitted, indicate that this man was a half-witted "degenerate."

of a witch that were found on the inside of her cheekes, she answered that those markes came by reason of an Impostume of the one side. And the other came by a Ragged tooth on the other side, and this was about 5 yeares since, and saith that Goody Todd badd her lay the curd of a lemon possett unto the said impostume (and Mrs Dunscombe was then present), which curd brake it And it hath bin ever since, and the other by the ragged tooth aforesd, which was filed by Thomas Dunscombe & further saith not.

(2) Thomas Dunscombe being examyned saith that if he did file any such Tooth of Goody Stevenson it was more than he remembers.

(3) The wife of Thomas Dunscombe being then examyned also sayth that she doth remember that Goody Stevenson askt her husband to file a tooth, but whether he did file it or noe, she knoweth not and further saith not."

A jury of women having been appointed to search her body, reported as follows:

"That upon the search of the body of Goody Stevenson, they found in her mouth two small Teates or Duggs, the one on the one side of her mouth & the other on the other side of her mouth, which they prick't with a needle, but there came forth noe blood at all from them and when they prickt they ask'd her if she felt when they prickt them, & she confest that she felt them not. And they say further that because they would not mistake, They did all severally search her mouth and prickt these Teates, but they affirm that there came not forth any blood when they did soe. And say also that they found a blew spott, or like wart . . . very suspitious & against natuer, out of which came waterish blood when they prickt it"

Her trial was a long one and contains abundance of grossly absurd testimony. She was accused of causing "grievous and tormenting paynes" upon the bodies of several persons, and the pigs and cattle of others, so that they died. The death of a child of a neighbor, probably from colic, was laid to her "diabolicall practises," though she appears to have been a well disposed old woman, who tried to help her neighbors in times of sickness and trouble.

She was convicted and hanged May 20, 1653

4. Trial of Alice Moore, 1653.

"The attestation of John Burt taken by the grand Inquest Maye the 17, 1653. Who saith that some yeares since he havinge a great sowe, eyther Goodman Moore or his wife, he remembereth not which of them, came to his house to buy the sowe. And he sett them a price but they would not consent to yt, And a matter of six weeks after the sowe pigged & then the sowe & all her piggs died & further said not."

Various other similar absurd attestations are recorded, which are here omitted.* The following is a part of the testimony of John Waynewright, who had previously quarreled with Mr. Moore:

* Among other things, she was accused of preventing the "coming of butter," and the compounding of soap by her neighbors.

"And not long after this I had many of my creatures strangly taken & died, as my cattell dyeing Soddaynly. And shoats running loose one hour dead the next & never could discern anything they ayled, neither living nor dead, but were as fatt and as lusty as any creatures in the world, yet perished About this tyme. I had sett according to my estimation about 16 acers of corne ground, which sprouted in the ground very well, some above ground and some arrived even of the ground and turned too & agen like the worme of a pease, & soe lay fresh in the ground & never came to good, though free from clodds or other ympediment. I never saw the like before or since."

"Not long after when I came out of England, I had a very fayre sowe pigging, & goodwife Moore being at my house & seeing her praysed her; not long after she pigged and all her piggs died as soon as they were pigged. At the tyme of Captn Turner's entrance into his Govment, or a little after, I did charg goody Moore with these and many things else. And first for that she should declare how she came to know that myselfe wth the rest of the company who were in the shipp with me were taken by the Turkes or chased by them."

A jury of twelve women appointed to search the body reported as follows:

"Who doe affirm that upon the search of the body of Alice Moore, afores'd, they have found 3 markes or teates, as to biggness, on the right side of her body & another in her mouth towards the almonds of her eares, & another between her tooes upon her left foote, wh teates or duggs being prickt by them did not bleed only a little waterish blood, & they say she did not sensibly feele when they prickt them, although they asked her if she felt them, & besides they say that they found also other suspitious mkes which are declared to belong to a witch upon some partes of her body, & also some blew spotts there also."*

"The Jury for the keepers of the liberties of Comonwealth of England doth present Alice Moore of Warwicke tribe of the said Islands, spinster, for that she not having the feare of God before her eyes has feloniously wickedly and abhominably consulted, contracted and consented to & with the Devill to become a witch as doth appeare by several signes & markes upon her body, and by her diabolicall practice in witchcraft hath destroyed the cattell & hogges of Mr John Waynewright and Thomas Gaplin, both of Warwicke Tribe, & of divers other persons contrary to the peace of the comonwealth of England and the dignity thereof."

"To w'h Indictment she pleadeth not guilty, but the Grand Inquest finding yt a true bill she put herself to be tried by God & the Cuntry w'h being a jury of 12 men sworne, find her guilty & for the same she was adjudged to be carried to the prison from whence she came & from thence to be conveyghed to the place of execution & ther to be hanged by the necke until she be dead, dead, w'h execution was performed accordingly the 20th of May, 1653."

The Grand Jury having thus caused the death of several harmless old women and a half-witted man, felt very proud of their work, and passed the following gratulatory resolution:

* Probably the "blew spots," often mentioned, were in most cases varicose veins.

"Wee the Grand Inquest, Taking into our consideration how it hath pleased God upon slight & slender ground being carefully followed upon one person for suspition of witchcraft, what good successe & yssues hath followed upon it, Therefore wee desire that All such persons as wee have hereunder mentioned may have some careful eyes cast upon them, soe that if it shall please our God to discover more of them they may be persued after and proceeded agaynst until, as David saith, wee have cut of wicked doers from off this Island." May, 1653.

5. Trial of Elisabeth Page, 1654.

The following persons, tried for witchcraft, were two passengers on the "Mayflower," whose captain stated that "hee did vehemently suspect them to be witches." They were both tried at one session of the court, Jan., 1654, but with very different results. The evidence was equally worthless and absurd in both cases, but the jury of women could find no moles on the body of the first one, and to that fact she undoubtedly owed her life.

"Charles Hancocke being sworne" "Saith that he being at the helme, Elizabeth Page had her finger over the compas, And yt ran round from North to South, And turned backe againe, And said that any woman that was wth child may make yt doe soe, And about 3 days after she told him that she had a steele needle about her that caused yt, yet other being present she s'd, do you not see how it runs, and further saith not." (Signed) CHARLES HANCOCKE.

The jury of women appointed to search her body found no moles. Their report was as follows:

"Who doe all affirm upon their oathes that they find not any marke or spotts or signes which may move them to judge Elizabeth Page to be a witch, only something more than ordinary (in a certain place."

"The Grand Inquest, 14 names. The Jury for life & death, 12 names.

"Wee the grand Inquest do present Elizabeth Page, being a passenger in the good shipp called the Mayflower, for that she not having the fear of God before her eyes wickedly and felloneously consulted & covenanted with the devill contrary to nature & to the law of God and man, And contrary to the peece of the comonwealth of England and the dignity thereof."

"To which Indictment Elizabeth Page pleaded not guilty &c., and for her triall put herselfe upon God & the country wch country being 12 sworne men, found her not Guilty and was quitt by proclamation."

6. Trial of Jane Hopkins, 1654.

"The attestation of Jeames Man before the grand Inquest the 3rd of January, 1655."

"Who sworne saith that he being in the caben wth Jane Hopkins, she, said Jane, wished that God might showe some signe whether she was a witch or not, and emediately there was a thing in the likenes of a ratt appeared unto them & further saith not." (Signed) JEAMES MAN.

"Before the Grant Inquest afores'd."

"Thomas Cobsone sworne, sayth that at the same tyme he saw a thing in the likenes of a ratt, after the said Janet Hopkins had wished that God might show some signe, and saith further that before the appearance there was a noyse which made him afearde."

Another female Jury of 10 women was empannelled to search Jane Hopkins. The MS. has here partly perished, but the words "search the body" can be read. (Ten names follow.) Lefroy.

"Who doe all joyntly affirm that Jane Hopkins hath in her mouth a suspitious marke and under her arme she hath a dugge or Teat, And upon her shoulder a wart, and upon her necke another wart . . . And they all declare that all these were insensible when they were prickt and tried."

"The Jury for the Commonwealth of England doth present Jane Hopkins, one of the passengers in the Mayflower, for that she not having before her eyes (sic) hath felonously and wickedly consulted and covenanted with the Devil & him hath suckled and fedd contrary to nature & the law of God and man, as doth appeare by markes & signes upon her body and contrary to the peace of the comonwealth of England & the dignity thereof."

"To which Indictment Jane Hopkins pleaded not Guilty and for her triall &c. She was found guiltie and for her sentence was condemmed to be carried to the place of execution and there be hanged by the neck until she was dead, dead, wch was done accordingly, as appeareth by his warrant dated the 5 January 1655."

So far as the records show, this was the last execution for witchcraft in Bermuda.

From 1655 to 1672, several other persons were tried for witchcraft and were mostly acquitted, in some cases merely because no moles were found on the body.

On June 12, 1671, Susan Cole was tried, convicted, and sentenced to be hanged. But on June 21st she was reprieved by Gov. Sir John Heydon: "Uppon waighty considerations," and returned to prison, "untill you shall receive further Order." What her final fate may have been is not recorded. Two women were prosecuted for witchcraft in 1684, but the records are incomplete and the result is not stated, though their bodies were searched for "signs."

The last record of a person prosecuted for witchcraft is that of Sarah Spencer, in 1696, but there is no record of her trial or sentence. So that these trials ceased here, about the time they began at Salem.

An old negro woman, called Sarah [or Sally] Bassett was convicted, in June, 1730, of trying to poison her master's family, and was legally sentenced to be burned at the stake. But this was not connected with the witchcraft delusion. (See Lefroy, Memorials, ii, p. 633.)

The Public Garden.

In 1896 an Act was passed to establish a Public Garden. Mr. Nathaniel Vesey, M.C.P., was largely influential in promoting this very worthy enterprise. The land purchased was to be not less than ten acres, and not to cost over £1550. A sum not exceeding £550, was provided for buildings, etc. It was to be entirely under the management and control of the Board of Agriculture. Salary of superintendent was to be £300, and the running expenses not over £150, annually. The Annual Reports to the Board of Agriculture to be published. Ten acres of land were bought in 1898, in Paget Parish, near Hamilton, and a house was built. Mr. Geo. A. Bishop was appointed superintendent, in 1898. His first report was on the "Diseases affecting the Lily in Bermuda, their cause, treatment, and prevention." Of this, 500 copies were printed and distributed. In 1899, additional grants were made for glass houses. The work of improving and planting the grounds has progressed very favorably. It will, without doubt, eventually become a very attractive place, and also of great benefit to the people, on account of the experiments and investigations that will be conducted there in agriculture and horticulture. At present the appropriations for its expenses seem very inadequate.

The Wild Birds Protection Act, 1902. [2nd September, 1902.]

WHEREAS it is expedient to consolidate the Acts mentioned in the second schedule hereto:

Be it therefore enacted by the Governor, Legislative Council and Assembly of the Bermudas or Somers Islands as follows:—

1. Any person who shall knowingly and wilfully shoot or attempt to shoot, or shall use any boat for the purpose of shooting or causing to be shot, any wild bird included in the first schedule to this Act, or shall use any lime, trap, snare, net or other instrument for the purpose of taking, capturing, or destroying any such wild bird, or shall expose or offer for sale, or have in his control or possession, any such wild bird, shall, on conviction of any such offence before any Justice of the Peace, forfeit and pay for every such wild bird in respect of which an offence has been committed, a sum not exceeding one pound, in addition to the costs, unless such person shall satisfy the Justice hearing the complaint that such wild bird came into the possession of such person before the passing of this Act under circumstances which would not have rendered such person liable to any penalty or forfeiture under either of the Acts mentioned in the said second schedule, or that such wild bird was sent to these Islands by some person residing out of these Islands, or was the offspring of birds kept in captivity before the passing of this Act.

2. Any person who shall knowingly and wilfully take, remove or destroy, or shall have in his control or possession, or shall expose or offer for sale, the egg of any wild bird included in the said first schedule to this Act shall, on conviction of any such offence before any Justice of the Peace, forfeit and pay for every egg in respect of which an offence has been committed a sum not exceeding five shillings, in addition to the costs, unless such person shall satisfy the Justice hearing the complaint that such egg came into the possession of such person before the passing of this Act under circumstances which would not have rendered such person liable to any penalty or forfeiture under either of the Acts mentioned in the said second Schedule, or that such egg was sent to these Islands by some person residing out of these Islands, or was the egg of a bird kept in captivity before the passing of this Act, or of the offspring of such a bird.

3. When any person shall be found offending against this Act, or under circumstances from which it may reasonably be concluded that such person has committed an offence against this Act, it shall be lawful for any other person to require such person to give his Christian name, surname and place of abode, and if such person shall, after being so required, refuse to give his real name or place of abode, or shall give an untrue name or place of abode, he shall be liable, on being convicted of any offence against this Act, to forfeit and pay in addition to any forfeiture incurred for such offence under this Act, such sum of money not exceeding ten shillings as the Justice hearing such complaint shall see fit to impose.

4. One half of every penalty or forfeiture imposed under this Act shall be paid to the informer and the residue thereof into the public treasury.

5. Any person who shall produce to any Justice of the Peace resident in the parish where such person resides, or if there be no resident Justice, to any neighbouring Justice, any crow dead or alive, or the egg of any crow, and shall satisfy such Justice that such crow or egg has been taken, killed, or destroyed in these Islands by the person producing the same, shall be entitled to receive from such Justice a certificate stating the number of crows or eggs produced to such Justice, in respect of which he shall be so satisfied as aforesaid, and on the production of such certificate to the Receiver General, or Assistant Receiver General, he shall pay out of the public treasury to the person named therein a reward of four shillings for every crow, so taken or killed, and of one shilling for every crow's egg, so taken or destroyed; provided that no reward shall be paid out of the public treasury unless it shall amount to four shillings at least, payable at one time to the same person; provided also that no Justice of the Peace shall grant any such certificate as aforesaid unless or until the crows and eggs produced to him shall in his presence have been so effectually destroyed and disposed of as to prevent the same being thereafter made use of for defrauding the public revenue.

6. This Act shall come into operation on the first day of October next, and from and after that date the Acts mentioned in the second Schedule hereto shall be repealed; except as to any prosecution for an offence against either of the said Acts committed within three months before the commencement of this Act, which offence may be punished within three months after the commencement of this Act in like manner as if the said Acts had not been repealed.

FIRST SCHEDULE.

The Red Bird, Blue Bird, Ground Dove, Chick of the Village, Quail, Partridge, Tropic Bird, Boatswain Bird or Long Tail, Humming Bird, King Fisher, Wood Pecker, Rice Bird, Crane, Heron, Gold Finch, Mocking Bird.

The acts named in the Second Schedule, as repealed by the above, are the Wild Birds Protection Acts of 1881, 1892, and 1894.

It will be noticed that several of the resident or breeding birds now existing here are not protected, viz :—

The Cat-bird, Wheat-ear, European Starling (believed to be already naturalized in small numbers), English Sparrow, and European Tree Sparrow.

The Cat-bird is undoubtedly of great use in destroying vast numbers of grubs and caterpillars which constitute a large part of its food, and this should more than offset the small amount of damage it does to small fruits. But it is so common and so well able to take care of itself that there seems to be no danger of its extermination, at present.

The European Wheat-ear is a small insectivorous bird, and therefore very useful. It is now quite common in some parts of the islands, especially near St. George's, and deserves full protection. The English Sparrow is extremely abundant and needs no protection, for it has "come to stay." Formerly a bounty was paid for its destruction, but to no good purpose. It destroys great numbers of caterpillars and other insects as food for its young in the breeding season, which is here a large part of the year. Therefore it probably does more good than harm, unless it destroys the eggs of other and better birds to an injurious extent. There is little if any occasion to protect the Humming Bird and Rice Bird, for they are only found as migrants from North America, and the former, at least, is excessively rare, and merely an accidental visitor. The other birds scheduled are in need of all the protection that they can have, though the Wood-peckers are only found as rare migrants. A general clause, providing protection for all land birds, excepting perhaps the English Sparrow, would seem to be desirable, for the numerous migrating birds do a large amount of good, even during the short time that they remain, by destroying insects and the seeds of noxious weeds.

It seems to me a mistake to offer a bounty for Crows, for there are probably not a dozen pairs left on the islands, moreover it is a bird that generally does much more good than harm, especially in a place

like Bermuda, where it can find abundance of its favorite shellfish for food on the sea beaches. It is also fond of grubs and snails, of which it destroys large numbers.

Food of the Bermuda Lizard, p. 697.

Specimens killed on Castle Island, a rather barren locality, were recently dissected by me to ascertain the nature of the food. Rather contrary to what might have been expected, the principal part of the food consisted of an Amphipod crustacean (*Orchestia agilis*), which is abundant under decaying sea-weeds at, and just above, high-tide mark, and therefore easily available for this lizard, which often lives in the crevices of the shore-cliffs and retaining walls. There were also remains of terrestrial Isopods, with a few ants and the elytra of a beetle. When living at a distance from the shore, it probably feeds principally on insects. Its food was pretty finely divided.

Additional Insects, etc.

Among the insects received from Mr. L. Mowbray in December and January were a few Hymenoptera, including males, females, and very small workers of one or two species of ants of the genus *Pheidole*, as determined by Mr. Th Pergande. These are common, as House-ants, and destructive. Also two small Ichneumon-flies, of the genera *Limneria* and *Cratichneumon*, determined by Mr W. H. Ashmead; and two other species. The material is not sufficient to determine the species. The small number of Ichneumon-flies hitherto discovered in Bermuda is very remarkable.

Mr. L. Mowbray sent early in January several fresh specimens of moths, which are of interest as illustrating some of the species that fly at this season. Five are additions to the fauna, though some are not fully determined. To Dr. H. G. Dyar, to whom this lot was sent, I am indebted for the following determinations:

Autographa rogationis Dyar, List of N. Amer. Lepid., p. 200, Dec., 1902=***Plusia rogationis*** Guen., Spec. Gen, vi, p. 344, 1852. Figure 288.

Plusia dyaus Grote, 1875.

Nearly black. Thorax with a large and high erect tuft of long hair-like scales; and a lower depressed tuft on each side, at bases of wings; another lower tuft on base of abdomen, inclined backward. Color of tufts, dark bronzy brown. Fore wings varied with black and dark lustrous bronzy brown; a large angular patch of black around the white silvery spots, which are conspicuous; inner one U-shaped; outer one ovate; marginal fringe and under side of wings, lighter bronzy brown. Length with closed wings, about 18^{mm}.

Prodenia eridania (Cram.); Dyar, List Lepid., p. 123. Figure 240.

Phalæna eridania Cram., Pap. Exot., iv, p. 133, pl. 358, figs. E, F, 1782.

Wings above, silvery gray, with irregular, small, black spots; under side of wings and body yellowish white. Length, with folded wings, 18mm. Jan., L. Mowbray. Widely distributed; southern U. States; Central and South America.

Anomis erosa Hübner, Zutr. exot. Schm., p. 19, figs. 287, 288, 1818.

Dyar, List N Amer. Lepid., Bull. No. 52, U. S. Nat. Mus., p. 205, Dec., 1902.

A handsomely colored moth; fore wings above light brownish orange on the basal half, but with a small brown basal patch; dark brown, varied with lighter brown, distally; the two areas separated by a thin crooked line of darker brown, which does not reach the posterior edge, but joins another similar proximal transverse line that curves outward; thus these lines bound an irregularly triangular, orange area, in which is a round brown spot, surrounding a well-defined, small, white central-spot; a dark brown reniform spot on the brown area, beyond which is a third, incomplete, transverse, brown line. The orange-brown areas, under a lens, are light orange, specked with red-brown scales; on the thorax is a tuft of similarly colored long scales; abdomen, above, yellowish brown with white borders. Hind wings below pale yellowish gray, specked with brown scales, and crossed by a median and a marginal brown line; legs yellowish white. Length, with folded wings, 17mm; of body, 14mm. The larva feeds on the cotton plant (t. Dyar).

In April, 1901, the most abundant moth that came in to our lights, especially late at night,* was a geometrid moth with the wings dull gray varying to light yellowish gray, both pairs of wings crossed by a darker median band, and with two less distinct and imperfect dark bands on the fore wings.

A fresh specimen of the same moth was sent by Mr. L. Mowbray, in January. Dr. H. G. Dyar, who has studied the specimens, thinks it a new species, and has furnished the following description:

Alcis verrilluta Dyar, n. sp.

Allied to *A. multilineata* Pack.; the wings similarly shaped and marked. Light gray, varying to light ocherous, the ocherous persisting in the gray specimens as a broad shade on both wings beyond the t. p. line. Lines pale gray, a shade darker than the wings, obscure, waved; t. a. line faint; median more distinct, common to

* This is the same moth mentioned above, p. 756, note, as ? *Heterogramma*.

both wings. T. p. line broad, obscurely double, the outer half broad and clouded, especially on hind wings, containing more or less distinctly a few brown dots. In the ocherous space beyond there are, on the fore wings, two brown spots, varying in size, situated between veins 3–4 and 6–7. Margin dark gray, shaded ; small black marginal dots. Head and body-parts gray ; wings below lighter, often ocherous ; fore wings with heavy median and marginal gray shades; hind wings with a straight t. a. band and a double median one just beyond a small discal dot ; margin gray-powdered. Expanse, 25–28^{mm} ; 16 specimens. April and May, 1901, and Jan., 1903. U. S National Museum, type, No. 6732.

Specimens were also sent, 1901, to Museum of Comp. Zoology.

239 238 240

Figure 238.—*Autographa*, or *Plusia*, *rogationis*. Figure 239.—*Gypsochroa sitellata*. Figure 240.—*Prodenia eridania*. All $\times 1\frac{1}{3}$. Phot. A H V

Plume-moth. (*Platyptilia pusillidactyla* Walker.)

This small Pterophorid moth, which has been determined by Dr. H. G. Dyar, is native of Jamaica, St. Thomas, Grenada, etc., but has not been recorded from the United States (t. Dyar).

Remigia repanda,* see p. 774 ; *Gypsochroa sitellata*, fig. 239, and see p. 776; and a plain silvery tineid (*Setomorpha*, sp.), were also in this lot. *Leucania*, or *Heliophila*, *unipuncta*, *Plusia rogationis*, and *Diaphania hyalinata* were sent in February.

Remigia repanda, p. 774. Add the following:

A mature larva, referred to this species by Dr. H. G. Dyar, was sent to me by Mr. L. Mowbray, in December. It differs considerably in color from the description on p. 775 (after Dyar).

Prolegs, 2 pairs, separated from the anals by 2 legless segments.

* Colors of this specimen much plainer and darker than in the U. S. specimen figured (pl. xcviii, fig. 6). Fore wings dark ocherous brown, with scarcely any distinct markings, except the three slightly darker cross-lines, and distal row of small obscure dark spots ; the wavy lines and speckled appearance are lacking.

Length, 42mm; diameter, 6mm. Color, sulphur-yellow on the sides and dorsal band, the latter bordered with a composite darker lateral band, on each side, of the same width, their margins formed by linear brownish black lines; 4 or 5 fine interrupted lines of the same color along the middle portion of each; the median dorsal band has a central line of greenish yellow; a darkish lateral band, consisting of 4 or 5 fine lines runs along the row of stigmata. A median ventral and a pair of subventral blackish bands are conspicuous, between which the ventral surface is covered with narrow alternating lines of yellow and brown, which cross the prolegs. Head with a dorsal whitish Y-shaped or yoke-shaped spot, enclosing a pale cordate spot; its sides are covered with alternating brown and yellow lines.

Hemiptera, p. 798. Add the following:

A larval Leaf-bug, sent by Mr. L. Mowbray in December, has the following colors: Body broadly ovate, convex above; abdomen prominently convex in the middle, below, but scarcely keeled.

Head, antennæ, and proboscis black; thorax, above and below, mostly black, its upper side with two dull yellow spots on each lateral margin; legs long, black; head with a yellowish mark on the sides, in front of eyes; abdomen dull red above, with a median row of 3 or 4 large, raised, black spots, and a marginal row of black, crescent shaped spots above and below the acute edge; a submedian and lateral row of round yellow spots on each side, the anterior lateral ones much the larger; abdomen, below, pale green, with a median row of squarish black spots. Length, 6.5mm; breadth, 4.5mm. The proboscis is long, reaching to the bases of the posterior legs.

Scale-insects, pp. 802–811. Add:

Mr. Geo. A. Bishop, has recently (early in Jan.) sent a number of additional scale-insects, still living. Some of them are accompanied by the active young larvæ, showing that they breed at this season. Several are additions to the fauna. They have been identified by Mr. C. L. Marlatt, as follows:

Dactylopius, sp. On the bases of the leaves of Pine-apple.

Dactylopius, sp.

On roots of *Panicum*, forming tufts of a white, downy secretion.

Another unknown coccid, forming similar white tufts, occurred on the joints of the stem of one of the reed-grasses (Arundinaceæ.)

Orthezia insignis Douglas. See above, p. 806.

On the leaves of *Coleus*.

Ceroplastes Floridensis Comst. (See above, p. 808, and fig. 180.)
On the leaves of the Laurel or Bay-tree.

Bamboo-scale. (*Asterolecanium bambusæ* Boisd.)
An elliptical, convex, rather large species, mostly covered with whitish grains, but plainly showing the blackish scale at one end.

The minute, living, active young of this were abundant, in this lot. On leaves of the Bamboo.

Fiorinia fioriniæ Targ.-Tozz.
Common on the leaves of the Laurel or Bay-tree, with living, active young in January. The same or a very similar species is common on the Avocado Pear and Loquat, according to Mr. Bishop. It is a small, dark brown, oyster-shell-shaped species.

Fig-Scale. (*Aspidiotus* (*Chrysomphalus*) *ficus* Ashm.)
Common on the leaves of Pomelo. It also attacks the orange and other citrus fruit trees.

Pine-apple Scale. (*Chrysomphalus*, sp., near *smilacis*.)
A large, flatish and ovate, grayish white scale, with the nucleus sub-central and somewhat excentric. On Pine-apple leaves.

Palm-scale. (*Aleyrodes*, sp.)
A nearly round, flatish, dark brown scale, on leaves of Palmetto.

The following three species were accidentally omitted from the list on p. 811.

Aspidiotus hederæ Vallot.
This species was recorded by Geo. B. King (Psyche, viii, p. 350, 1899), as found on a cycad from Bermuda. It is now generally regarded as identical with *A. nerii.* (See above, p. 810, fig. 184, *e.*)

Aulacaspis elegans=*Howardia elegans* Leon.
This was found with the preceding, by Mr. King.

Mytilaspis Floridensis.
According to Mr. Bishop this occurs on the orange. (Indentified by Mr. L. O. Howard.)

Introduction of Scale-eating Coccinellids. (See p. 805.)

Mr. Geo. A. Bishop writes that he has already experimented in this way, by introducing *Vedalia cardinalis*, *Novius bellus*, *N. Kœbelei*, *Rhizobius ventralis*, and others. But whether with success is yet uncertain.

Yellow-fever Mosquito. (*Stegomyia fasciata.*)
As mentioned on p. 865, a specimen of this species has been taken

in January. It appears to be a very common species in Bermuda in summer and autumn. It is usually darker in color than our figure (100) would indicate, especially when somewhat rubbed, so as to loose its dorsal thoracic stripes of white scales, when the thorax and abdomen are dark brown, or blackish, each segment of the abdomen having a narrow, and often inconspicuous, basal band of white; wings dusky, with black veins; legs conspicuously banded with black or dark brown and white, the last two tarsal joints of the hind legs nearly all white except tips, others white on the basal third; femora light brown on basal half, blackish distally; tibiæ black. Palpi with white tips, front of head and vertex white; proboscis black, somewhat crooked, with a double curvature

White Ant, p. 817. Add the following:

Dr. Ogilvy (Bermuda, Past and Present, p. 39) thus records a White-ant: "The dreaded white-ant has also been found, doing much damage to wood-work and stores, but is not widely diffused." Whether the species observed by him was *C castaneus* is, of course, very uncertain. Of the latter, Mr. Mowbray sent in December a fresh specimen, taken in a dwelling house. It is a "soldier," remarkable for the great size of the light chestnut-brown head, which is larger than the whole body, and for the very long and strong dark brown jaws. Determined by Mr. N. Banks.

Figure 241.—Scorpion (*Centrurus gracilis* Ger.). Phot. A. H. V.

Scorpions, p. 830. Add the following:

Centrurus gracilis Gervais. Figure 241.

The specimen referred to has since been forwarded to me by Mr. L. Mowbray. Mr. N. Banks has identified it as this species.

Length, 100^{mm}; breadth of thorax, 14^{mm}; length of palpi, 35^{mm}; of claws, 15^{mm}.

Color, above, very dark chestnut-brown, with pale interstices between the larger segments, and pale grayish patches on their sides; under side lighter brown, becoming yellowish on the under side of the thorax. Pedipalps dark brown, the claw reddish brown; legs brownish yellow; tail dark brown, above and below, angular, concave above, with two finely denticulate carinæ on each side.

Cephalothorax sculptured with denticulate raised lines; larger abdominal segments with a median dentate carina and a smaller one each side of it, also with transverse dentate or granular raised lines, strongest one on the posterior edge.

Common in the West Indies; also found in So. Florida (t. Banks).

Governor Wm. Reid; his unpublished correspondence with Mr. Wm. C. Redfield.

On p. 857, mention is made of 8 volumes of these unpublished letters. They are mainly devoted to discussions of storms and the laws that govern them, subjects in which both writers were eminent authors and experts. But many other subjects are also referred to, and especially the Governor's efforts to improve the agriculture and schools of the islands. During his entire term of six years, 1839–46, Mr. Redfield volunteered to act as his financial agent in New York, and not only helped him in the sale of his book on the Law of Storms (two editions), but bought and forwarded books, periodicals, plows, rakes, yokes, and all sorts of agricultural implements, etc., including a horse and saddle. Also a large variety of seeds of garden vegetables and other plants, annually. The Governor refers to his getting acts passed to establish a Public Library; a Museum of Natural History; the Lighthouse; Agricultural Fair, etc

In a letter of June 28, 1840, replying to a question by Mr. Redfield, he says: "The wound you enquire about, I received in the neck, at the first assault of San Sebastian by the Duke of Wellington, I happen to have been twice shot severely in the neck, having been four times wounded, and had three horses shot under me,—so that I often wonder at being here and still alive in this world."

Referring to an abusive personal criticism in some American newspaper, he says, that he received no government aid whatever in publishing his work on the Law of Storms, but paid out at least £600 sterling to publish it. Also: "My being appointed Governor of Bermuda was not to enable me to study storms of wind, but because I had seen a good deal of *storms of war*, and I never saw the minister who named me until I went to receive my instructions." He also states that he disliked politics and parties, and never interfered with them, and adds: "I never gave a vote in my life at an election and never tried to influence any man in giving his."

"I believe the appointment did more credit to the Colonial Minister than to me, for I heard that on reading the 'Law of Storms,' he was so much struck with the grandeur of the subject that he made enquiry of the writer; and finding him only a hardworking soldier, sent and asked him to go to Bermuda as Governor."

In letters of Oct. 18th and 24th, 1848, he speaks of having been ill two months and near death from yellow fever. He also gives a good brief account of the geology of the islands, and states that the rock is formed of wind-drifted shell sand.

ERRATA.

Page 424, line 10, for west, read east.

Page 470, line 11, for 26, *e*, read 26, *d*, p. 621.

Page 514, last line, for 1621, read 1622.

Page 555, line 12, for Silas, read Silvanus.

Page 579, line 10, for L. H., read L'Her

Page 579, line 9 from bottom, for *Elæaginus*, read *Elæagnus;* also on p 626, line 8 from bottom.

Page 580, line for *Cæsalpina*, read *Cæsalpinia*.

Page 581, line 12, dele FIGURE 42.

Page 581, line 15, for 26, *e*, read 26, *d*, p. 621.

Page 585, line 10, dele FIGURE 48.

Page 609, line 1, for *Xanthoxylum*, read *Zanthoxylum*

Page 622, line 1, add: The seeds germinate while still on the trees, and thus have rootlets when they fall into the water

Page 627, line 6, for lantannas, read lantanas

Page 630, line 7 from bottom, for G. B , read L B

Page 635, line 25, for 1887, read 1724

Page 638, line 17, for sap, read sop

Page 639, line 18 from bottom, for 1850, read 1840

Page 651, line 15, for west, read east.

Page 683, last line, and 684, line 7 from bottom, for Mr. Hayward, read Mr. Thos B. Hayward

Page 688, line 7 from bottom, for 1792, read 1856.

Page 688, line 10 from bottom, and p. 690, lines 6, 19, for Mr Hayward, read Mr Thos B. Hayward.

Page 718, line 10, for *Lasiomyteris*, read *Lasionycteris*.

Page 725, lines 21 and 27 from bottom, for Saville, read Savile.

Page 736, lines 1 and 22 of note, for PLATE LXXXIII, read PLATE XCVI.

Page 740, line 5, for 225, read 265.

Page 756, line 4 from bottom, for *? Heterogramma*, read *Alois Verrillata*, see p. 890

Page 767, lines 9, 20, for *Chærocampa*, read *Theretra;* under cut, for $\times 1\frac{1}{8}$, read $\times 1\frac{1}{8}$

Page 772, dele last six words.

Page 773, line 1, and page 782, line 1, for *exigua*, read *frugiperda* S. & Abbot. Probably the true *exigua* has not been taken in Bermuda. The figure, 134, and description apply to the latter.

Page 776, lines 11, 18, 24, for *Diaphana*, read *Diaphania*.

Page 782, line 22, for *Hallesus*, read *Halesus*.

Page 790, line 4 from bottom, for Dej., read DeG

Page 796, line 11, for Ev., read Er.

Page 796, line 22, after *villosus*, insert (Grav.)

LIST OF CUTS IN THE TEXT.

The illustrations of scenery are mostly from photographs made by my son, A. Hyatt Verrill, during our visit in 1901; a few were made by my son, C. S. Verrill, in 1898; several are from purchased photographs by artists unknown to me. Several botanical cuts are from photographs by Dr. W. G. Van Name, of our party, in 1901. Many are from drawings by A. H. Verrill. A large part of the cuts of insects, birds, fishes and reptiles, and some others, are from Webster's International Dictionary, by permission of the publishers, G. & C. Merriam Co.; most of these were also from drawings by A. H. Verrill, made under my direction. These are numbers 43, 44*b*–50, 52–55*a*, 58, 59, 61, 62, 91, 101, 102, 110, 111, 113, 117, 120, 121, 124, 129, 132, 133, 136, 137, 140, 141, 143, 144, 145, 146, 149, 150, 153, 154, 157, 160, 161, 165*a*, 166*a*, 167, 168, 171–174, 176, 177, 181, 182*a*, 183–185, 186*b*, 187, 188, 196, 198, 200, 201, 213, 224–225, 229. In general the source of each cut is given, if known

Our acknowledgments are also due to Messrs A. E. Outerbridge & Co., New York, agents of the Quebec Steamship Co , for numerous courtesies, which contributed very materially to our success in obtaining photographic illustrations and collections

Figure 47.—Green Turtle.

Figure 48.—Hawksbill Turtle or Tortoise-shell Turtle.

Figure 49.—Loggerhead Turtle.

Figure 50.—Leather-back Turtle.

The seven preceding cuts are from Webster's International Dictionary.

Figure 51.—The native Bermuda Lizard (*Eumeces longirostris*), × about 1½. Phot. from nature by A. H. V., 1901.

Figure 52.—Green Angel-fish (*Angelichthys ciliaris* Jord. and Everm.). From Webster's International Dictionary, drawn from nature by A. H. V.

Figure 53.—White Mullet (*Mugil Braziliensis*); altered from U. S. Fish Com.

Figure 54.—Rockfish (*Mycteroperca bonaci*); drawn from nature by A. H. V.

Figure 55.—Bermuda Hogfish (*Lachnolaimus maximus*), about $\frac{1}{10}$. Drawn by A. H. V., after Cuvier.

Figure 55*a*.—Amber-fish (*Seriola Dumerelii*); about $\frac{1}{8}$ nat. size. Drawn by A. H. V., after Cuvier.

The five preceding cuts of fishes are from Webster's International Dictionary.

Figure 56.—A large Bermuda Lobster (*Panulirus argus*) and a characteristic Bermuda fish trap. Phot. 1901, by A. H. V.

Figure 57.—Land Crab (*Gecarcinus lateralis*); $\frac{1}{2}$. Drawn from life by A H. V.

Figure 58.—American Quail or Bobwhite (*Colinus Virginianus* (L.) Les.).

Figure 59.—Mocking-bird (*Mimus polyglottus* (L.) Brewer). This and last preceding from Webster's International Dictionary.

Figure 60.—European Goldfinch (*Carduelis carduelis* (L.) Schäf.). Phot. from life, 1901, by A. H. V.

Figure 61 —American Goldfinch or Thistle-bird (*Astragalinus tristis* (L) Cab.).

Figure 62.—European Starling (*Sturnus vulgaris* L.). This and preceding from Webster's International Dictionary. Drawn by A. H. V.

Figure 63.—American Blue-tailed Lizard (*Anolis principalis* L.), × 2. Phot. 1901, by A. H. V.

Figures 64, 65.—Great Surinam Toad or Agua Toad (*Bufo agua* Daud.), about ⅓ nat. size. Phot. 1901, by A. H. V.

Figure 66.—*Pedipes tridens* Pfr. Drawn by A. H. V.

Figure 67 *a*, *b*.—Native Bermuda Snail. (*Pœcilozonites circumfirmatus* (Redf.) Pilsb.), × 2½. Drawn by A. H. V.

Figure 68, *a*, *b*.—Native Snail (*Thysanophora hypolepta* (Shutt.) Pilsb.), × 10. Drawn by Pilsbry.

Figure 69, *a*, *b*.—Native Operculated-snail (*Helicina convexa* Pfr.), × 2. Drawn by A. H. V.

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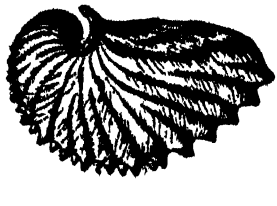

EXPLANATION OF PLATES.

Most of the following plates are half-tone reproductions from photographs made by my son, Mr. A. Hyatt Verrill, during our visit to Bermuda in 1901.* Several relating to Botany were made by Dr W G Van Name, of our party, in May, 1901. A few photographs of scenery were purchased, and I was unable to ascertain by whom some of these were made Others are from drawings made by A H Verrill, as indicated under each. They were engraved by the Gill Engraving Company of New York. The pages referred to are the original ones.

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* The number of photographs obtained during this visit was very large, because Mr. Verrill took his horse and buggy to Bermuda and was thus able to visit all desirable localities at favorable times.

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PLATE XCIV.

Figure 1.—Bermuda Lobster (*Panulirus argus*). P. 705. Photographed from nature by A. H. V.

Figure 2.—1, 2, Devil fishes (*Octopus rugosus*); much reduced; 3, "Rock-sucker" (*Chiton marmoreus*); 4, crab (*Geograpsus lividus*), as seized by Octopus; 5, fragments of the Spotted Cowry (*Cypræa exanthema*) and of the Cliff-crab (*Grapsus grapsus*) destroyed by Octopus; 6, Squid (*Loligo Pealei*); 7, common Starfish (*Asterias tenuispina*); 8, Red Sea-anemone (*Actinia Bermudensis*); 9, Green Sea-anemone (*Aiptasia tagetes*). From a drawing, by A. H. V.

PLATE XCV.

Figure 1.—Coney; Nigger-fish; Guativere; Ouatilibi (*Bodianus fulvus* (L.) Jord. and Ev.) P. 701. About 1/3 natural size.

Figure 2.—Hamlet; Hamlet Grouper (*Epinephelus striatus* (Bloch) Jord. and Ev.) About ¼ natural size. P. 701.

Figure 3.—Yellow-finned Rockfish or Grouper (*Mycteroperca venenosa* (L.), *apua* (Bl.) J. and Ever.) About 1/6 natural size. P. 699.

Figure 4.—Tiger Rock-fish (*Mycteroperca tigris* (Cuv. and Val.) Boulang.). About 1/10 natural size. All much reduced; after drawings from life and photos from mounted specimens for details, by A. H. Verrill.

PLATE XCVI.

Figure 1.—Scissors Grinder; Bermuda Cicada (*Cicada Bermudiana*, sp. nov.); male; × 1⅓. P. 736.

Figure 2.—The same, under side of smaller male; × 1⅓.

Figure 3.—North American Cicada (*C. tibicen*); natural size.

Figure 4.—Orange branch and fruit infested by the Purple Scale (*Mytilaspis citricola*), × 1⅓. P. 808.

Figure 5.—The same scale on another branch; *c*, *Chionaspis citri*, white male scales; × 1⅓.

Figure 6.—Orange branch more enlarged; *a*, Purple Scales; adult females; *c*, *Chionaspis citri;* male scales; from life. All phot. by A. H. Verrill.

PLATE XCVII.

Figure 1.—Rose-banded Sphinx (*Phlegothontius cingulatus*); ⅞ natural size. P. 766. Photo. by A. H. V.

Figure 2.—Larva of the same, on Morning Glory (*Ipomœa purpurea*); natural size. Photographed from life by A. H. V.

PLATE XCVIII.

Figure 1.—*Banasa euchlora;* ×3. P. 798.

Figure 2.—*Orthezia insignis* Douglas; ×6. P. 806.

Figure 3.—Cut-worm Moth (*Agrotis ypsilon* (Rott.); ×1½. P. 771.

Figure 4.—Cut-worm Moth (*Peridroma incivis* (Guen.); ×1½. P. 771.

Figure 5.—Cut-worm Moth (*Feltia malefida* (Guen.); +1½. P. 772.

Figure 6.—Grass Moth (*Remigia repanda* (Fab); +1½. P. 774.

Figure 7.—*Autographa*, or *Plusia, ou* Guen.; ×1½. P. 775.

Figure 8.—*Autographa*, or *Plusia, ou* Guen. P. 775.

Figure 9.—*Gypsochroa sitellata* (Guen.); +1½. P 776.

Figure 10.—Snout-beetle (*Diaprepes*); ×3. P. 785. All photographed by A. H. V.

PLATE XCIX.

Figure 11.—*Trox scaber;* ×1⅜. P. 792.

Figure 12,—*Trox suberosus;* ×1⅝. P. 792.

Figure 13.—Click-beetle (*Monocrepidius lividus* (Dej.); ×1⅞. P. 795.

Figure 14.—Ground-beetle (*Agonoderus lineola* (Fab.); ×3⅛. P. 797.

Figure 15.—*Trox scabrosus* Beauv.; ×1⅝. U. S., not Bermudian.

Figure 16.—White Ant (*Calotermes castaneus*); ×3⅛. P. 817.

Figure 17.—*a*, *b*, *c*, Frosted Leaf-hopper (*Ormenis pruinosa* (Say). P. 801; *a*, Leaf-bug (*Lygus*, sp.); both ×2½. Phot. A. H. V.

Figure 18.—Carolina Grasshopper (*Dissosteira Carolina*), resting on sand, showing protective coloration; nat. size. P. 821. Phot. by A. H. V.

Figure 19.—*a*, American Cockroach (*P. Americana*); an Egyptian specimen; *b*, Surinam Cockroach; a Mexican specimen; both identified by Saussure. P. 824, 825. Phot. by A. H. V.

Figure 20.- Australian Cockroach (*Periplaneta Australasiæ*), ×1¼; *a*, adult male; *b*, female; *c*, larva; *d*, nymph. P. 825. Phot. by A. H. V., from Bermuda specimens.

PLATE C.

Figure 1.—Centipede (*Scolopendra subspinipes*); natural size. P. 842. Photograph from life by A. H. V.

Figure 2.—Centipede (*Scolopendra subspinipes*); under side of anterior part, nat. size. Phot. A. H. V.

Figure 3.—Head and poison fangs of Centipede; *a*, antennæ; *b*, palpi; *c*, *c'*, poison fangs or first pair of thoracic legs; *d*, their basal joint; *e*, second pair of legs.

Figure 4.—*Tetrastemma agricola;* compressed and viewed as a translucent object; ×2; *a*, cephalic ganglions; *o*, œsophagus; *g*, *g*, intestine; *x*, anus; *r*, proboscis pore; *p*, *p'*, proboscis sheath; *l*, its ligament; *d*, armature of proboscis; after Moseley. P. 847.

Figures 6-9.—Black Sea-side Earwig (*Anisolabis maritima*); 6-8 are specimens from Thimble Islands, Conn.; 7 is an adult male; others females; 9 is a female from Bermuda, ×$1\frac{1}{4}$. P. 827. Phot. A. H. V.

PLATE CI.

Figure 1.—Trunk-back Turtle. Taken at Bermuda in 1901. Weight about 900 pounds. P. 697. Phot. by L. Mowbray.

Figure 2.—Hawksbill Turtle. Weight about 60 pounds. P. 694.

Figure 3.—Young Sperm Whale, taken off Bermuda in 1901. Length about 28-30 feet. (See p. 690.) Phot. by L. Mowbray.

PLATE CII.

Portrait of Admiral Sir George Somers, the "Father of Bermuda," to whom the original settlement, in 1611, was mainly due. He died in Bermuda, Nov. 9th, 1610, aged 56. His heart was buried, by his request, at St. George's, where a suitable tablet marks the spot. His body was taken to England for burial, at Whit-church, Dorsetshire. See pages 537-545. He was evidently a man of great ability, courage, and fortitude. According to *Fuller*, Worthies, 1622, he was "a lamb on the land; so patient that few could anger him," but "a lion at sea, so passionate that few could please him." He was born at or near Lyme Regis, 1554; knighted in 1604. The engraving is copied from a copper-plate of an authentic unpublished portrait that has remained continuously with his descendants, and of which a copy, made by Lieut.-Col. B. A. Branfil, was secured by Governor Lefroy. See pp. 541, 873.

PLATE CIII.

Portrait of Capt. John Smith, Historian of Virginia, New England, and the Summer Isles, 1624-1632. See Bibliography, p 854.

He was one of the original settlers of Virginia in 1607, and was chosen president of the Jamestown, Va., colony in 1608-9. There is no evidence that he ever visited Bermuda. (See pp. 552, 554.) The engraving is from an ancient copper-plate, representing him at the age of 37 years, in 1616. He was born in Lincolnshire, Eng., Jan., 1579; died in London, June, 1632.

For the fate of Pocahontas and her three maiden companions, see p. 514, note.

PLATE CIV.

Portrait of the late General Sir John Henry Lefroy, Governor of Bermuda from 1871 to 1877. A worthy contributor to the History and Botany of Bermuda. From a photograph presented to J. M. Jones in 1877. See p. 858, note.

Governor Lefroy was the compiler and editor of the "Memorials of the Bermudas," in 2 volumes, 1877-9, and of the "Historye of the Bermudaes or Summer Islands," by Governor Nathaniel Butler, 1882. These two works contain most that is known of the history of the Bermudas during the 17th century. He was also author of an important work on the Botany of Bermuda, Washington, D. C., 1884, and many other works. See Bibliography, pp. 851-859.

ERRATA.

Page 427, line 8, for Empress Eugenie read Princess Louise.
Page 600, add to foot-note. This cedar was also recorded from the same locality by Grisebach, in 1849, Ray Soc., v, i, p. 289.
Page 612, line 2, for Wing read Ming.

INDEX.

The pages refer to the original paginations, which, in the author's edition, are placed on the inner margins.

Figure 245.—Southern Army-worm and Moth (*Laphygma frugiperda*), nat. size; after Packard.

Figure 246.—Portuguese Man of War (*Physalia arethusa*), ½, after L. Agassiz.

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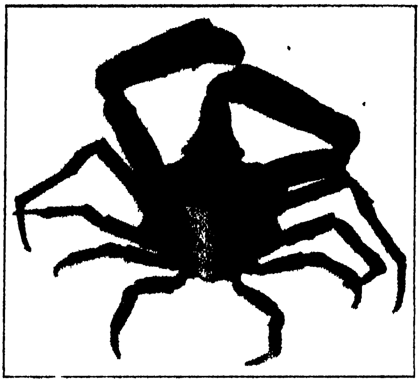

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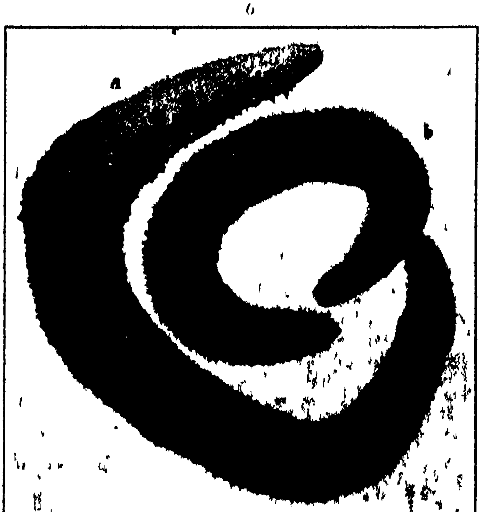

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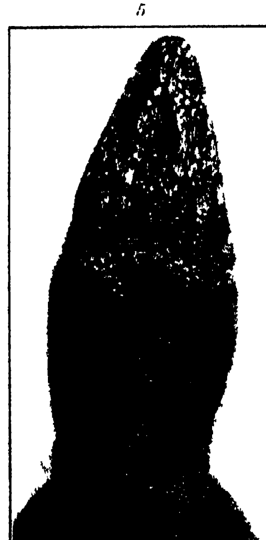

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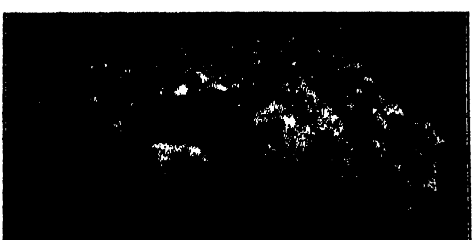

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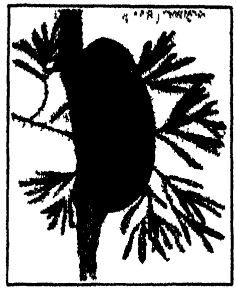

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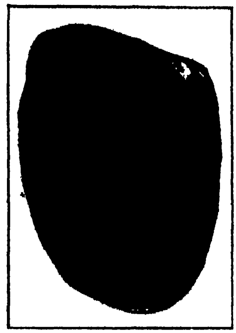

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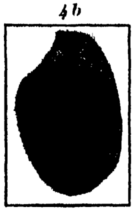

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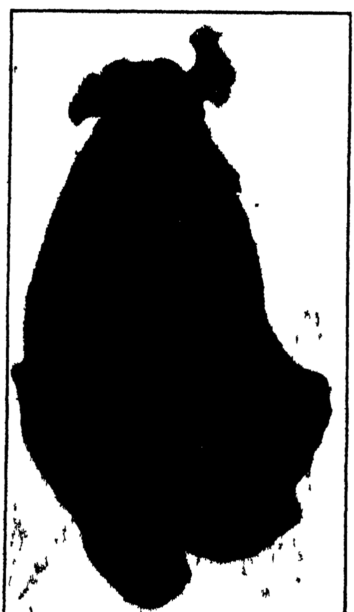

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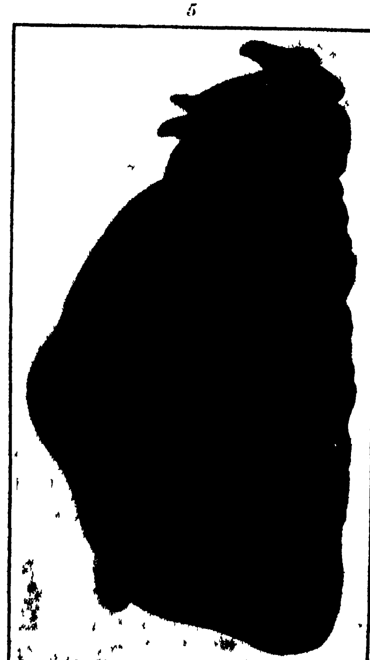

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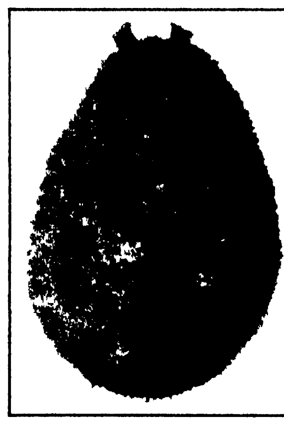

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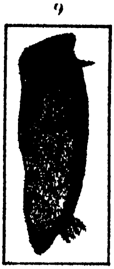

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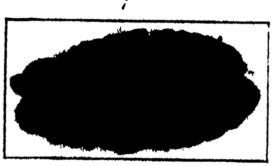

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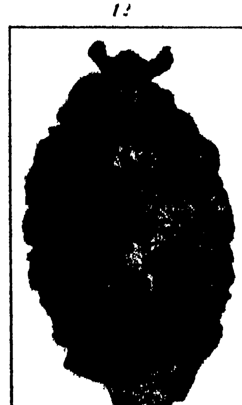

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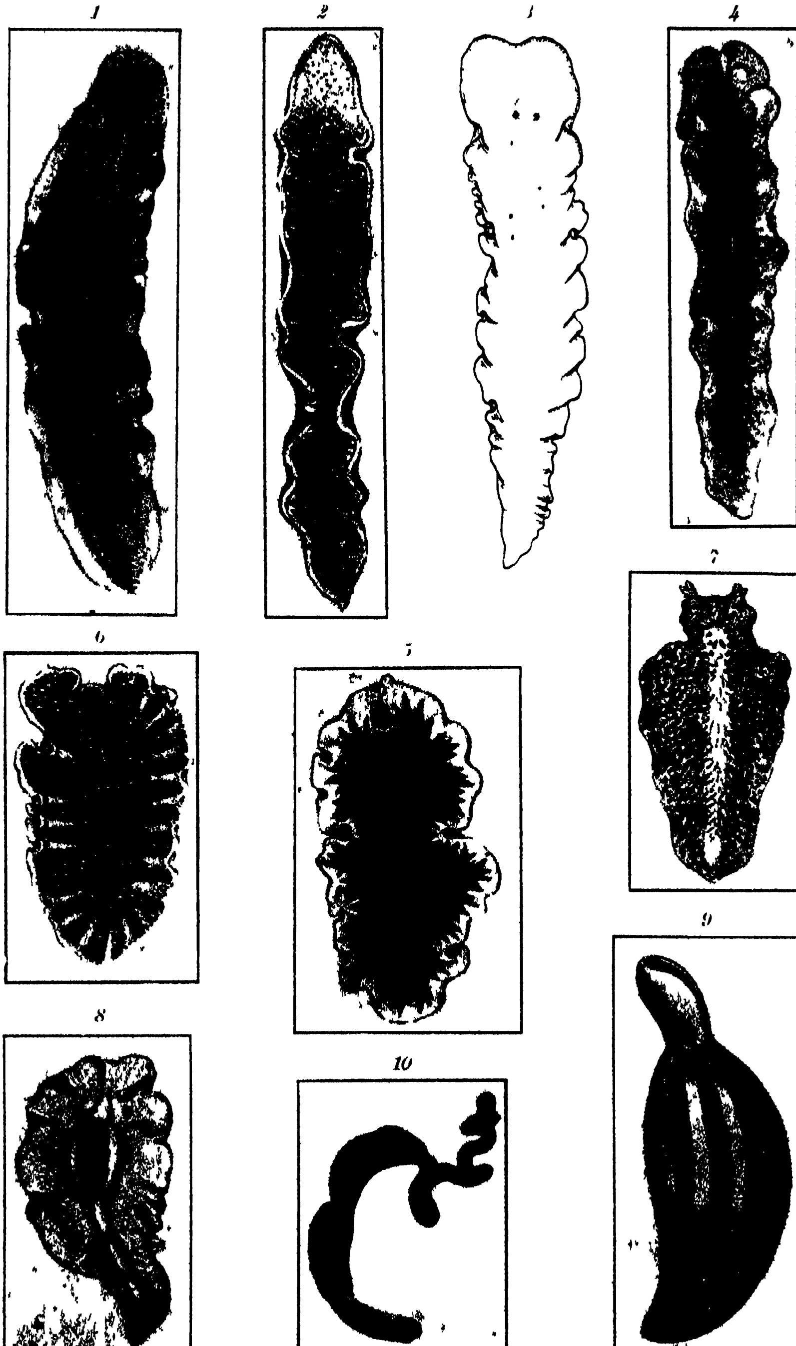

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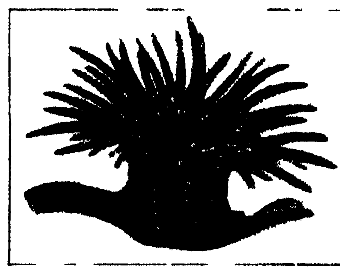

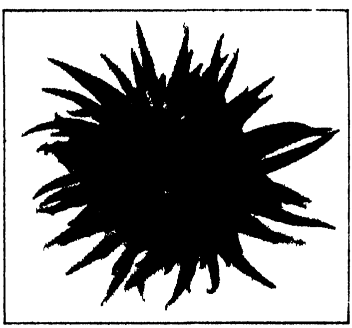

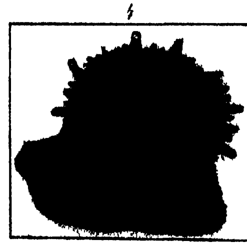

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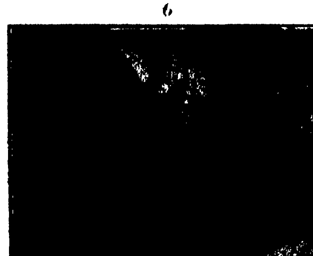

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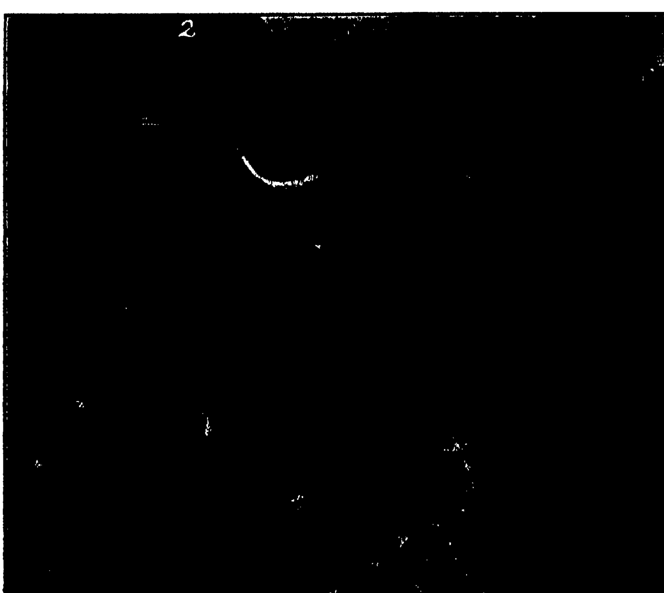

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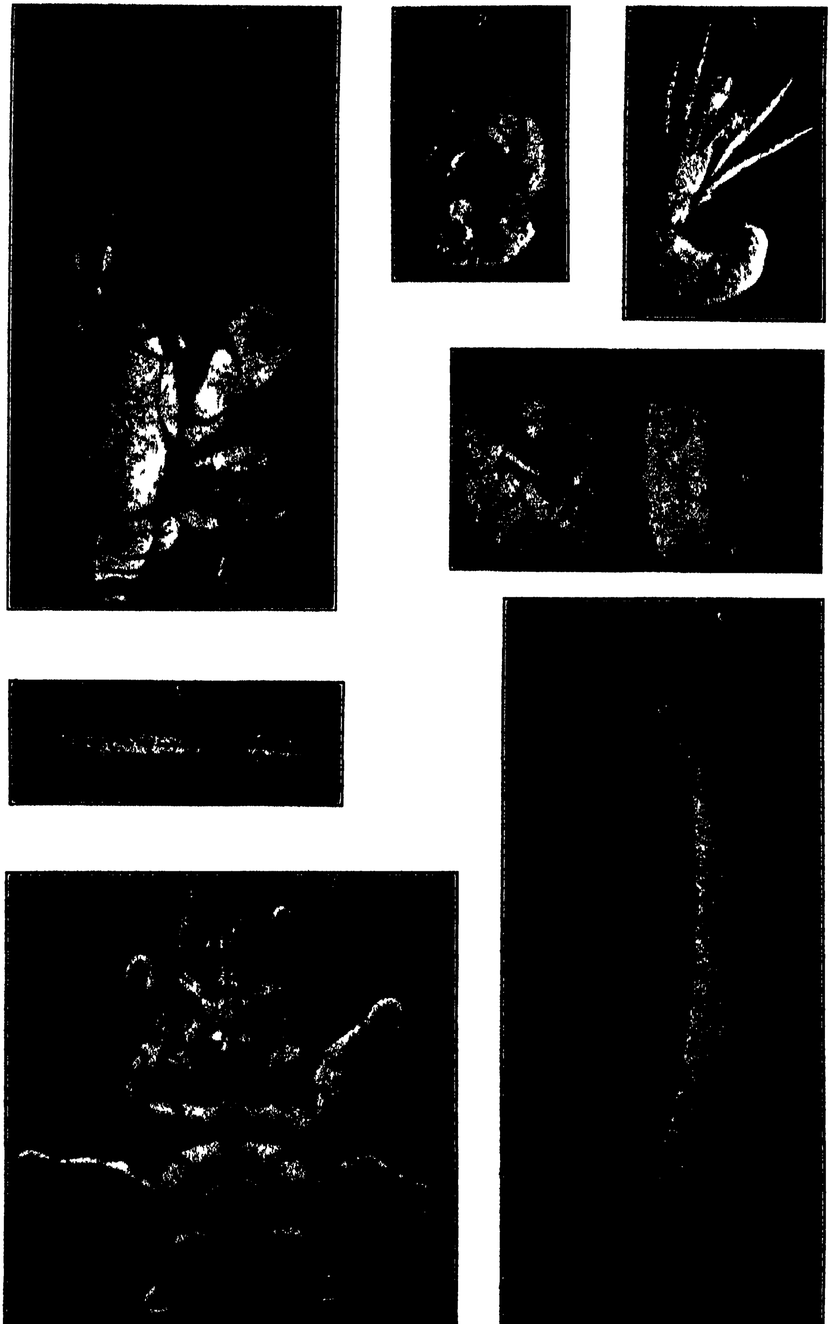

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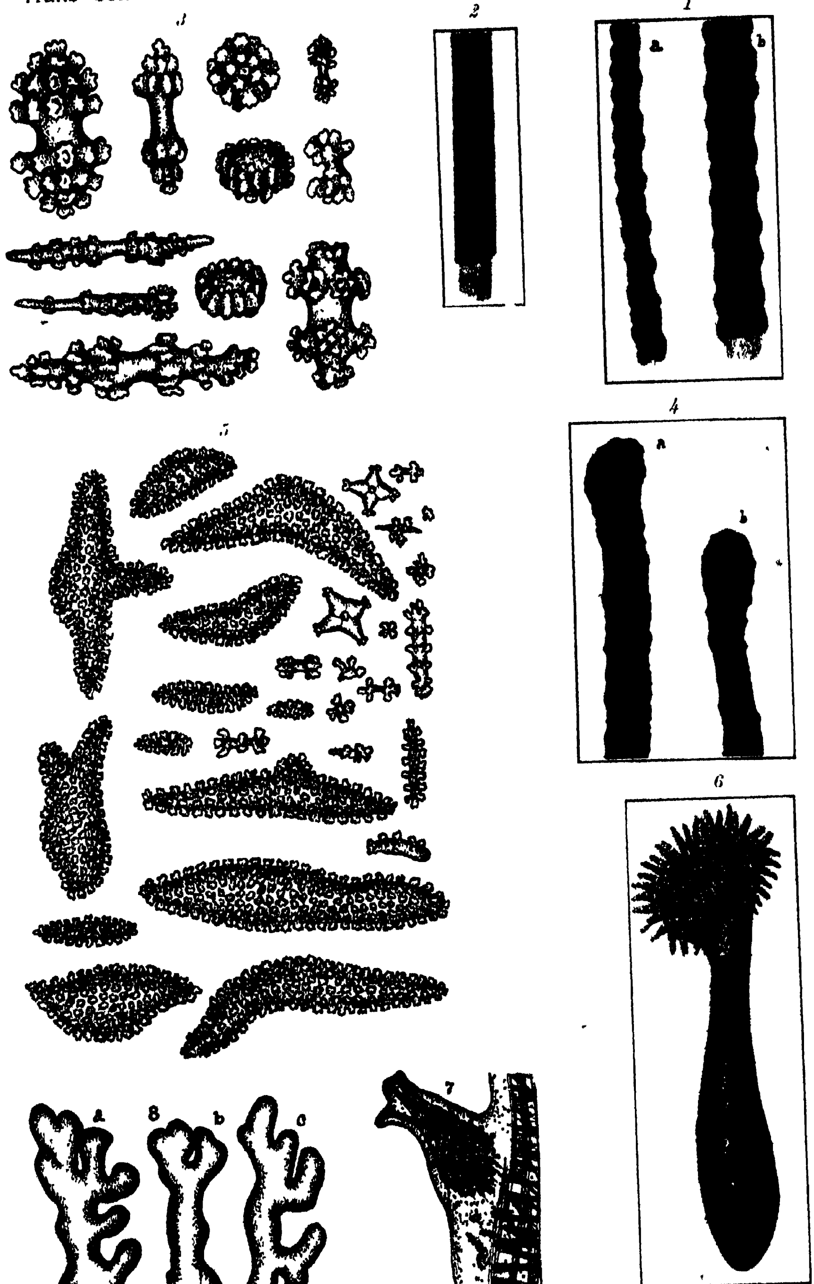

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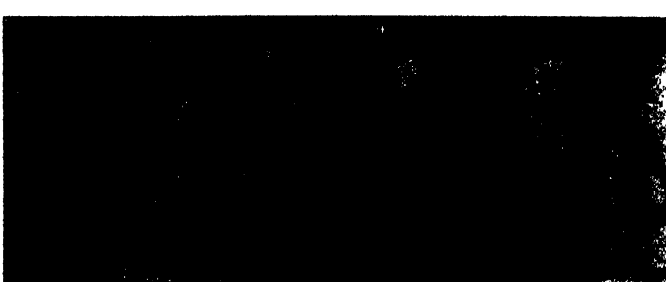

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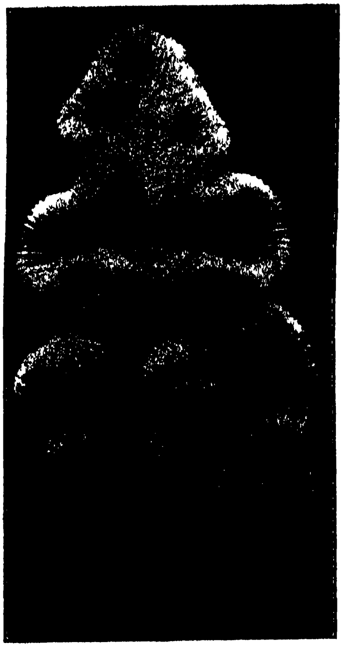

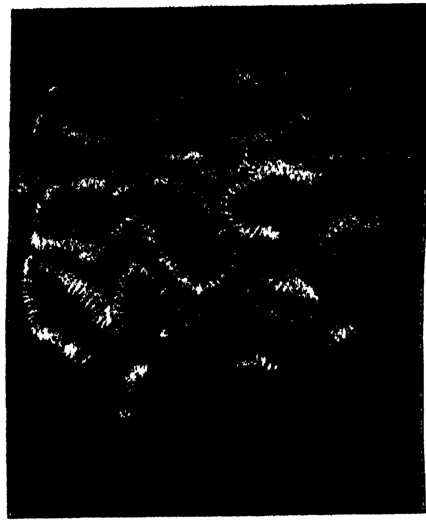

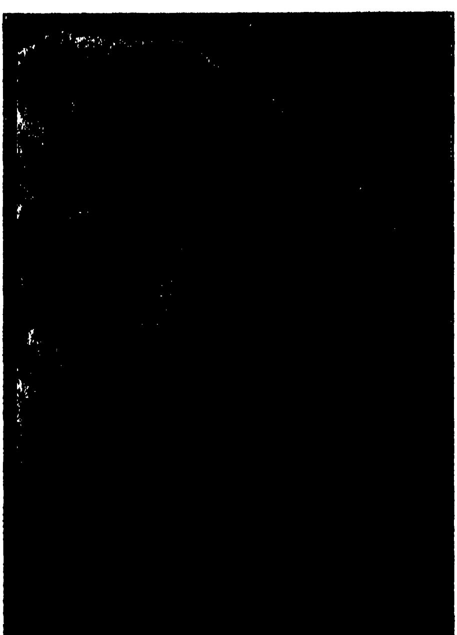

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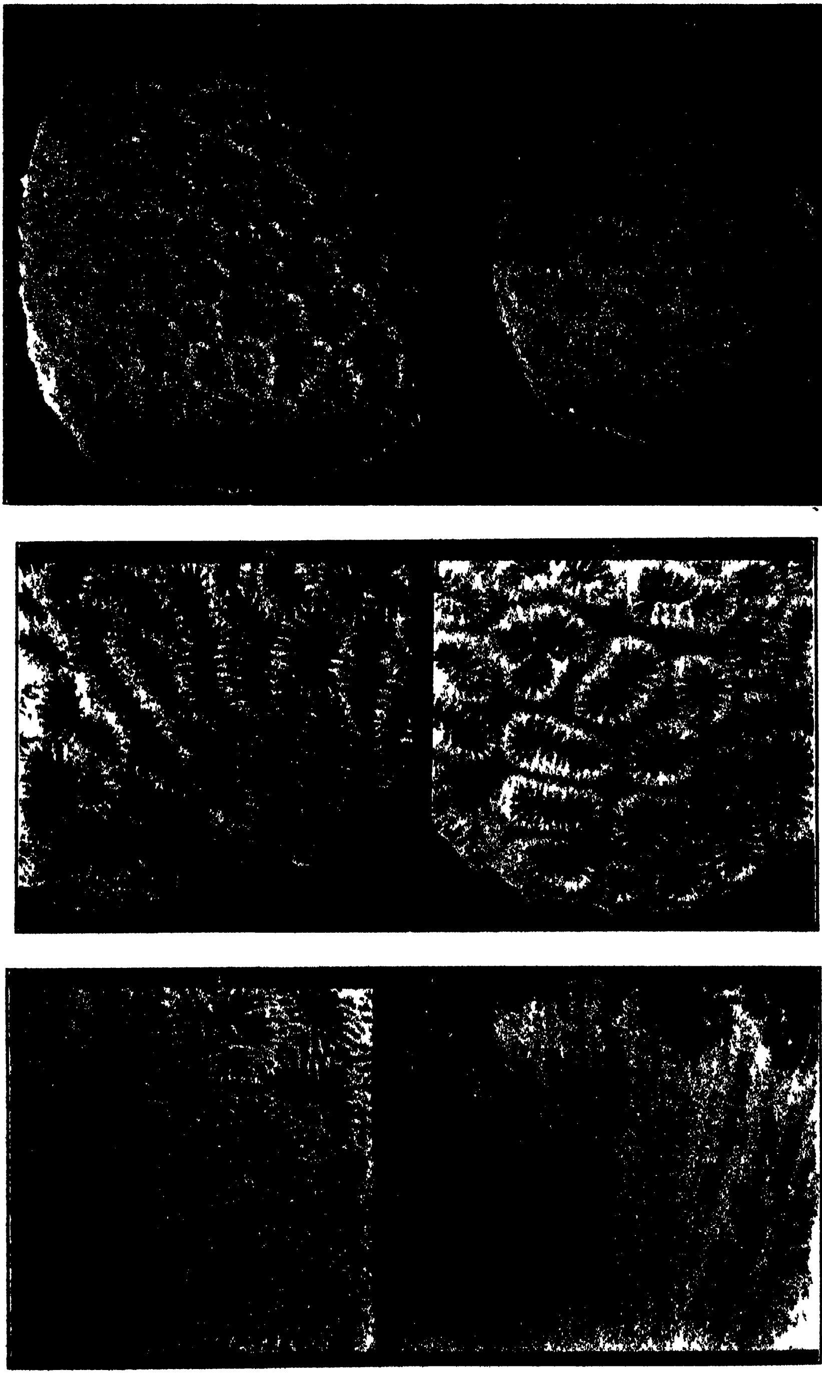

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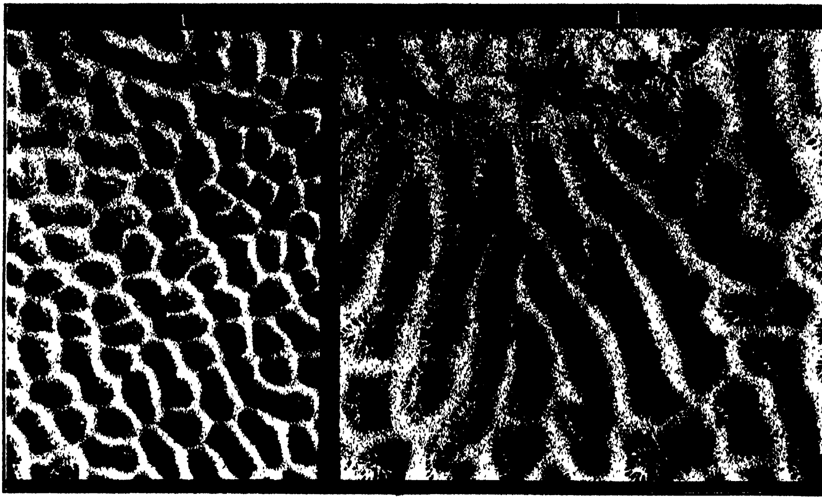

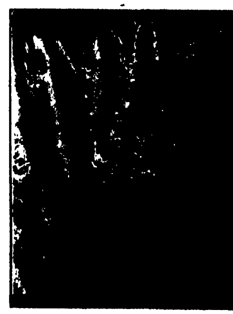

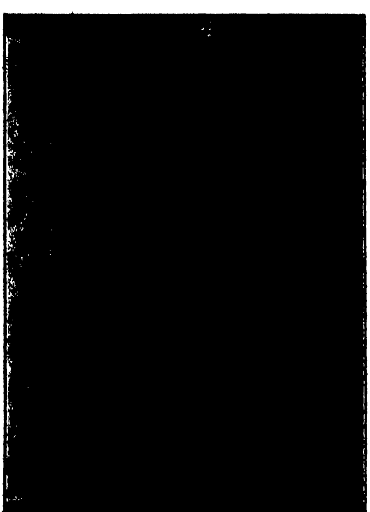

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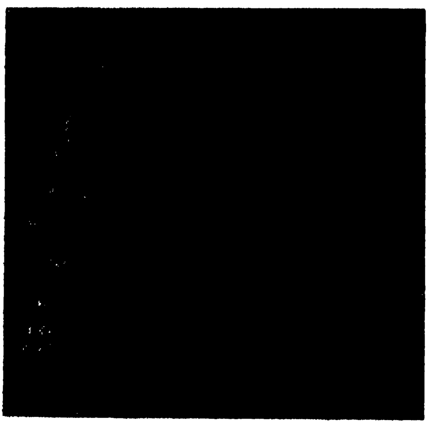

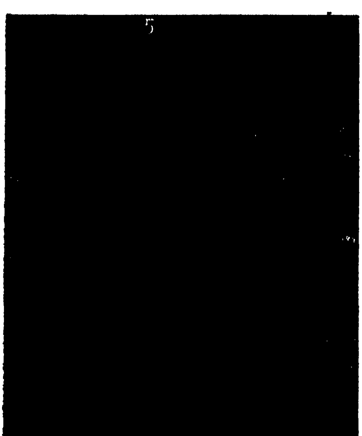

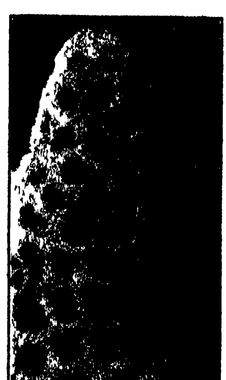

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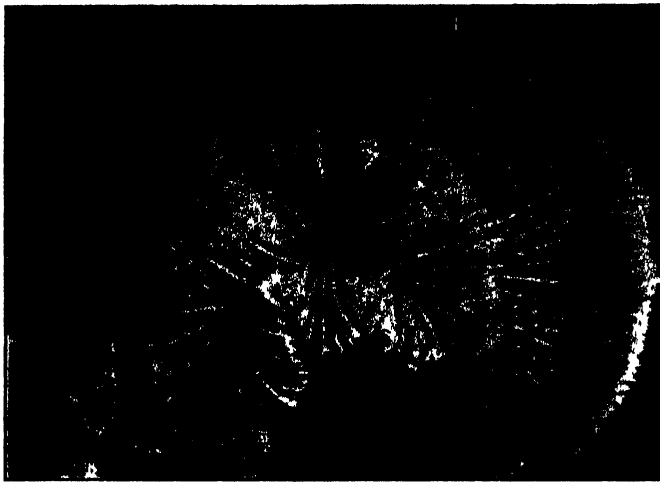

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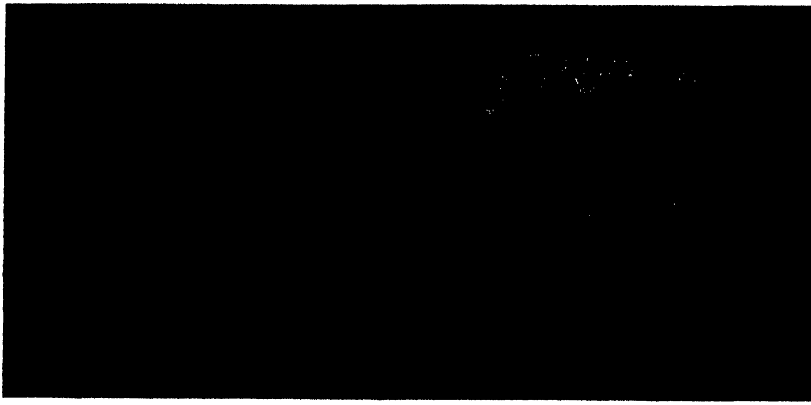

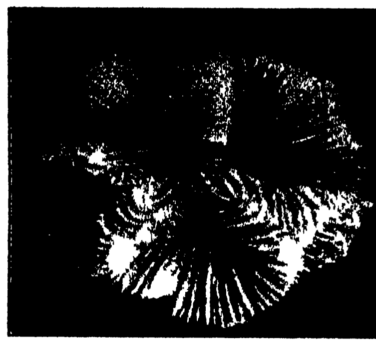

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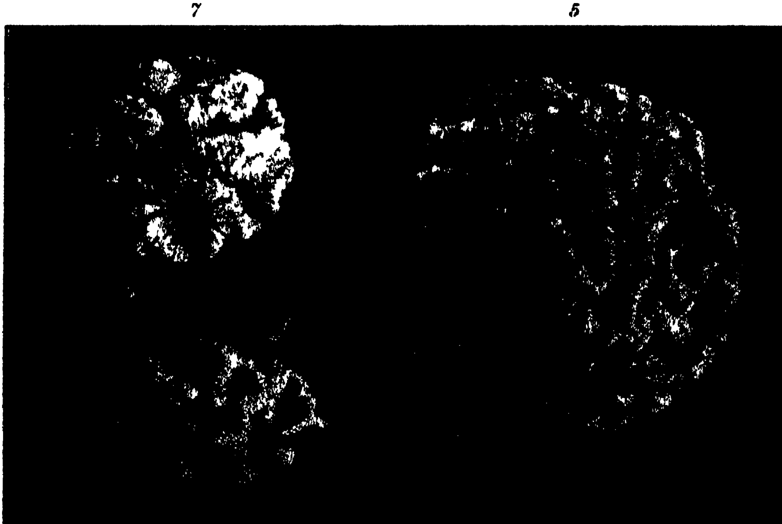

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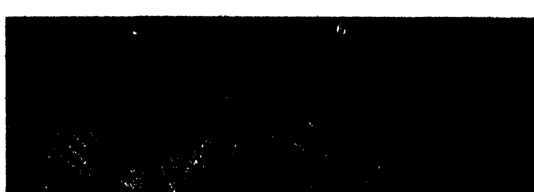

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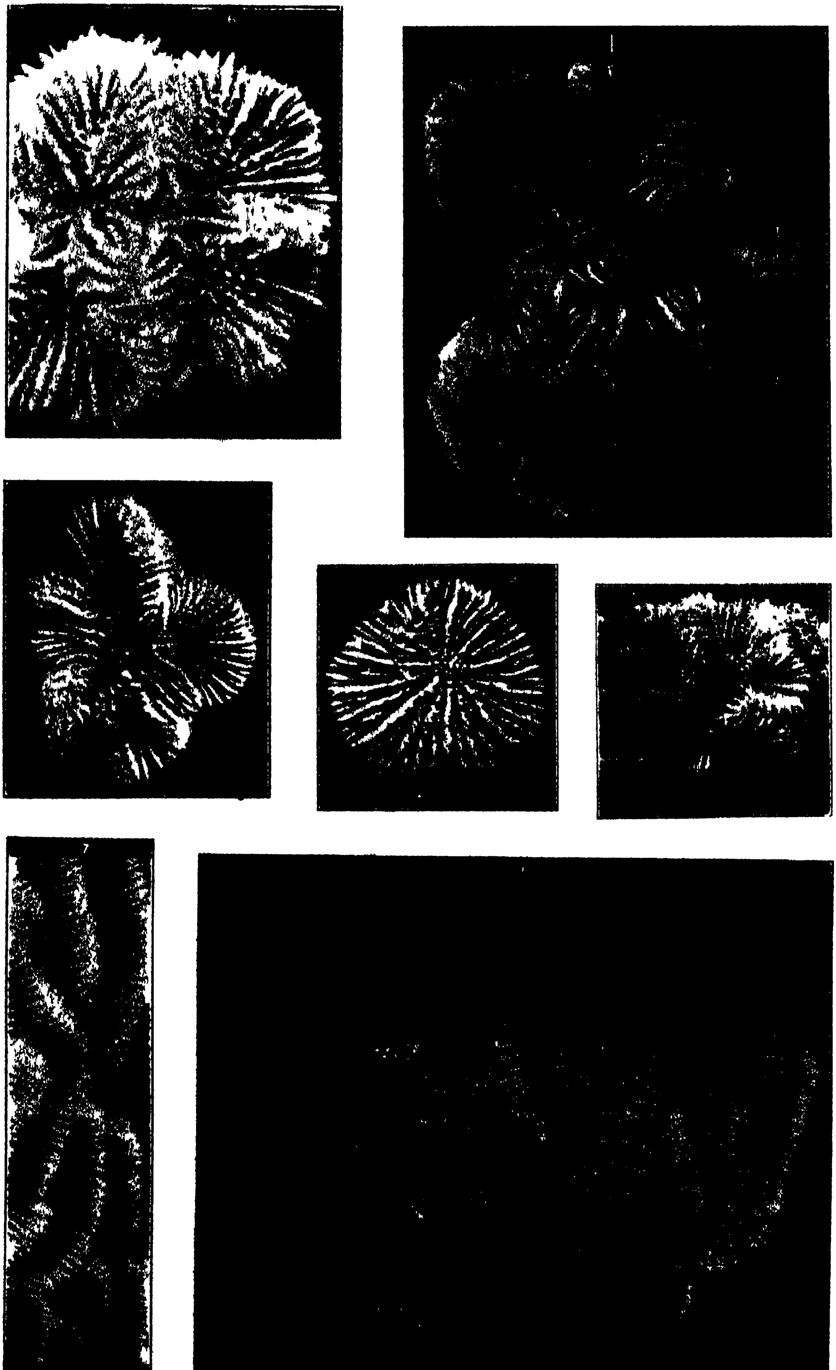

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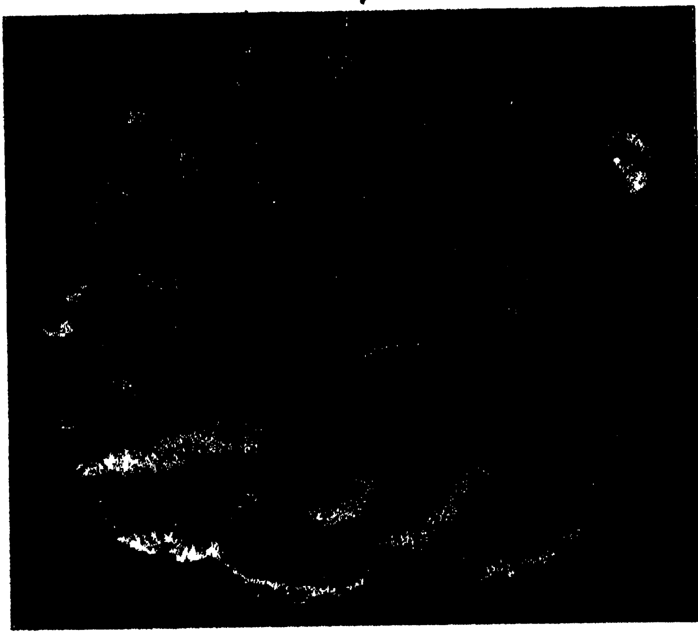

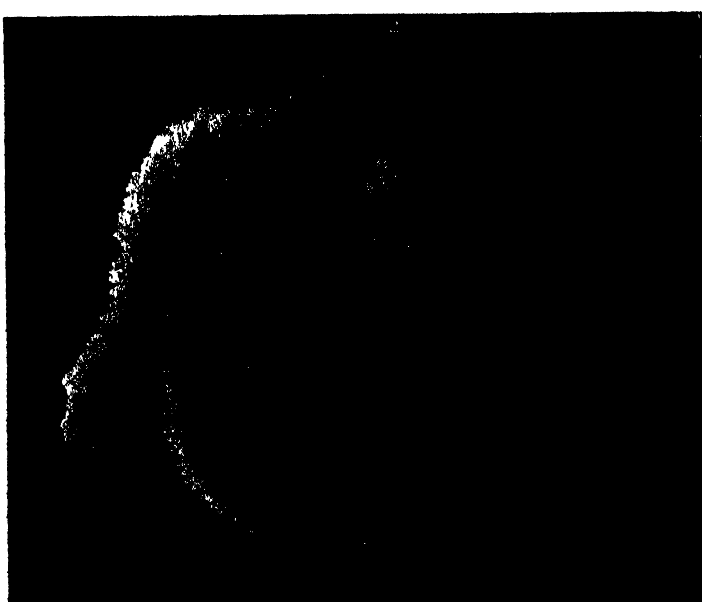

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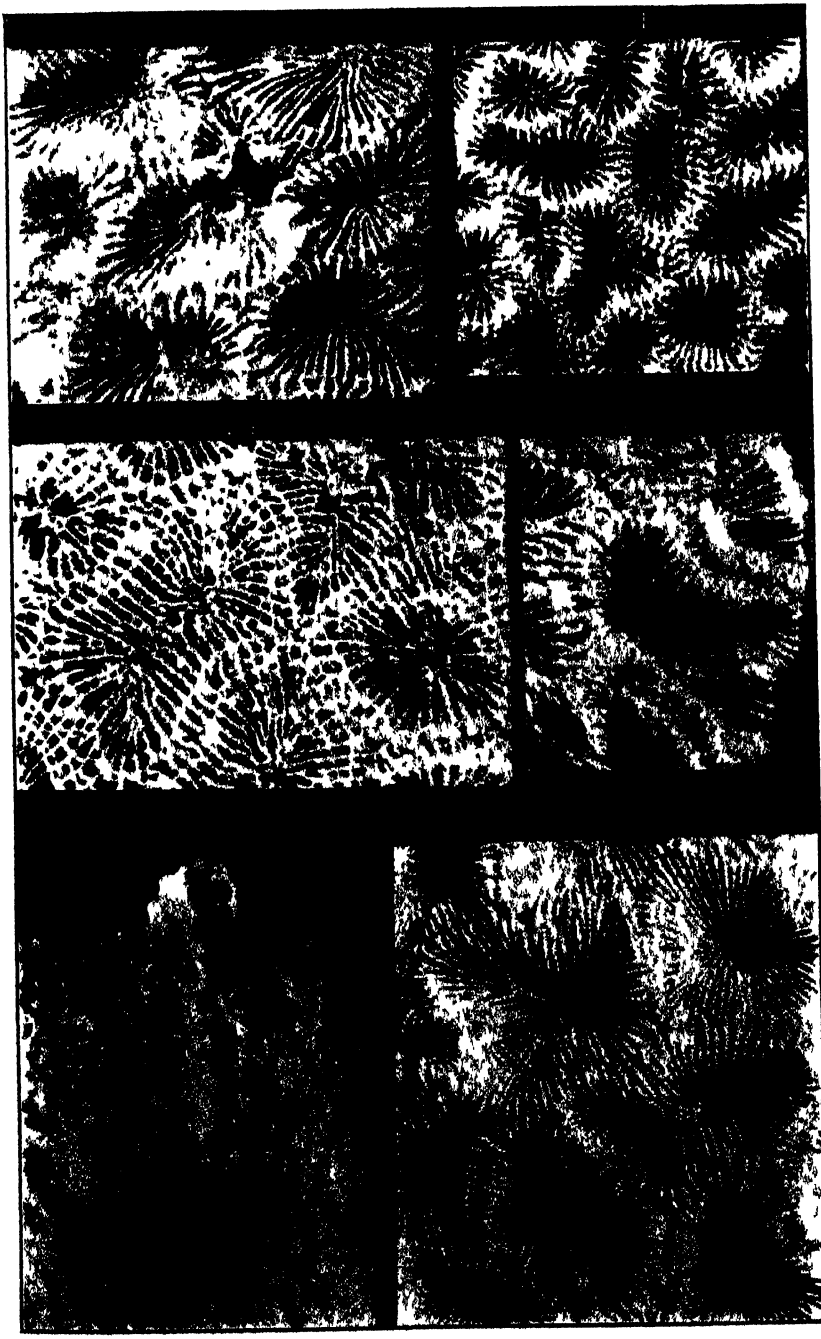

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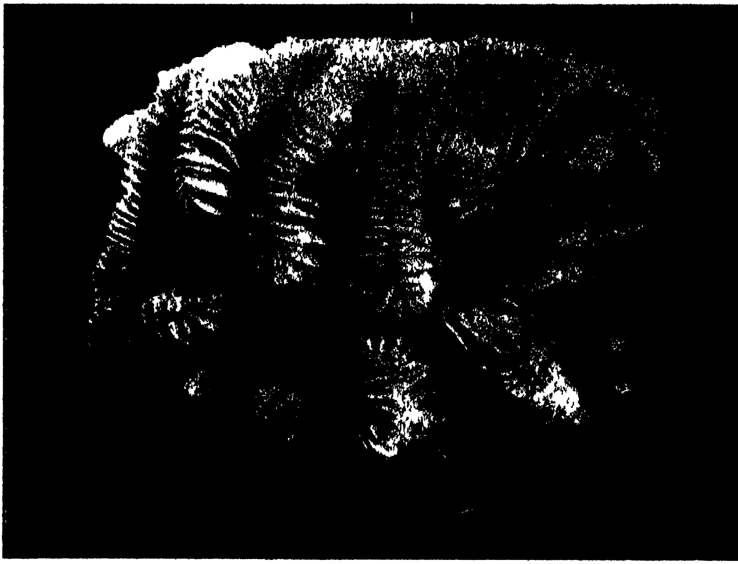

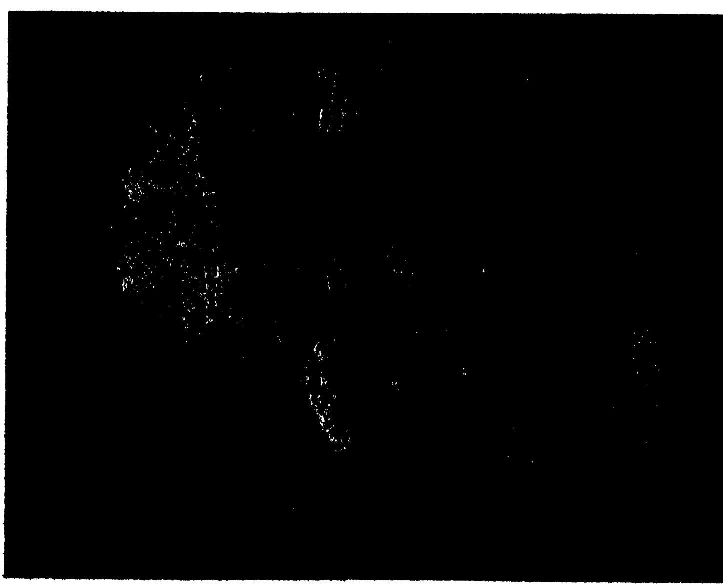

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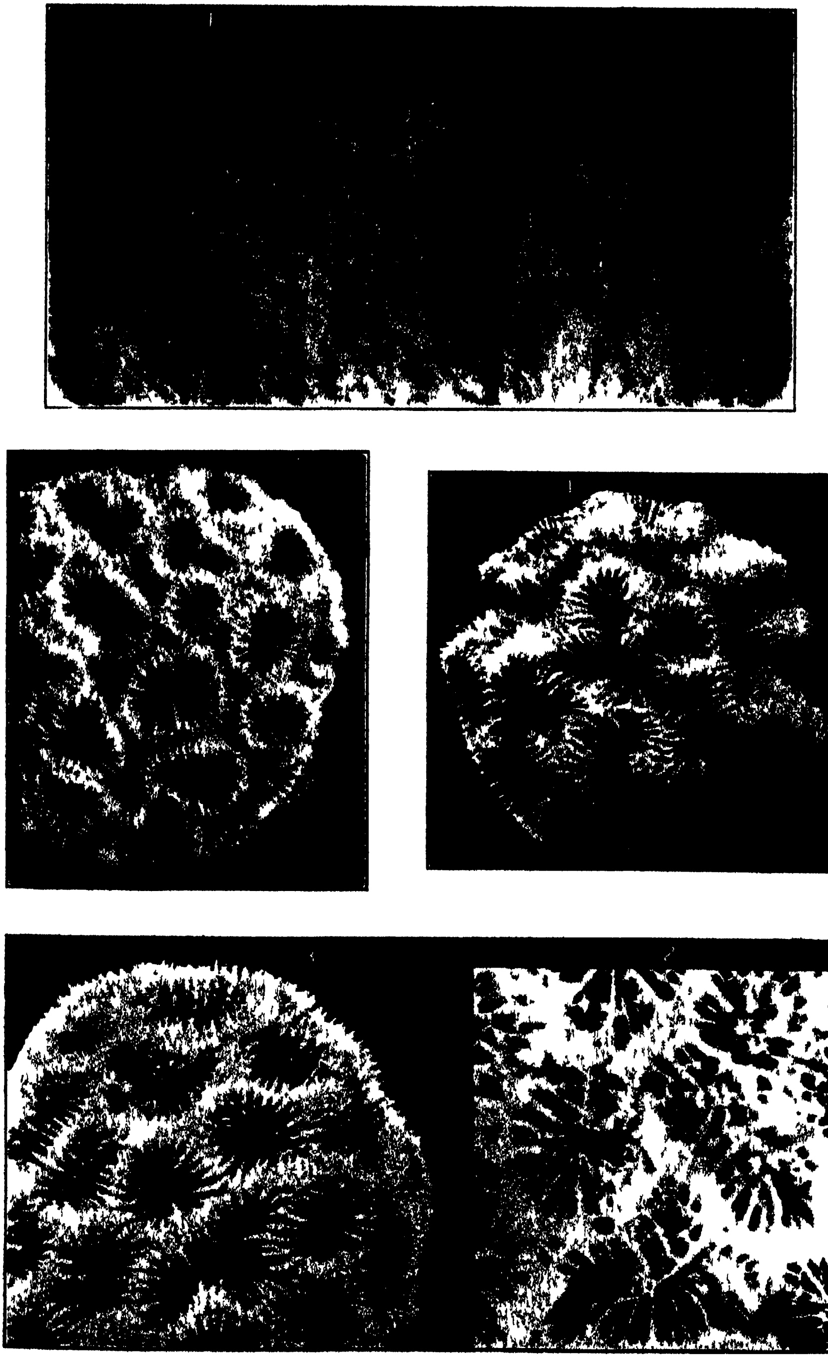

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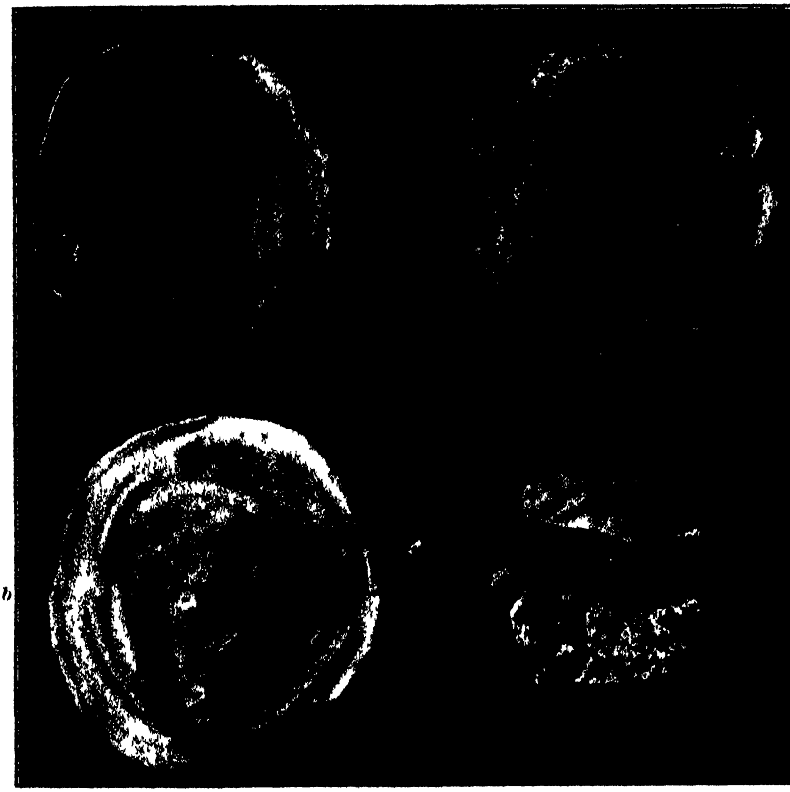

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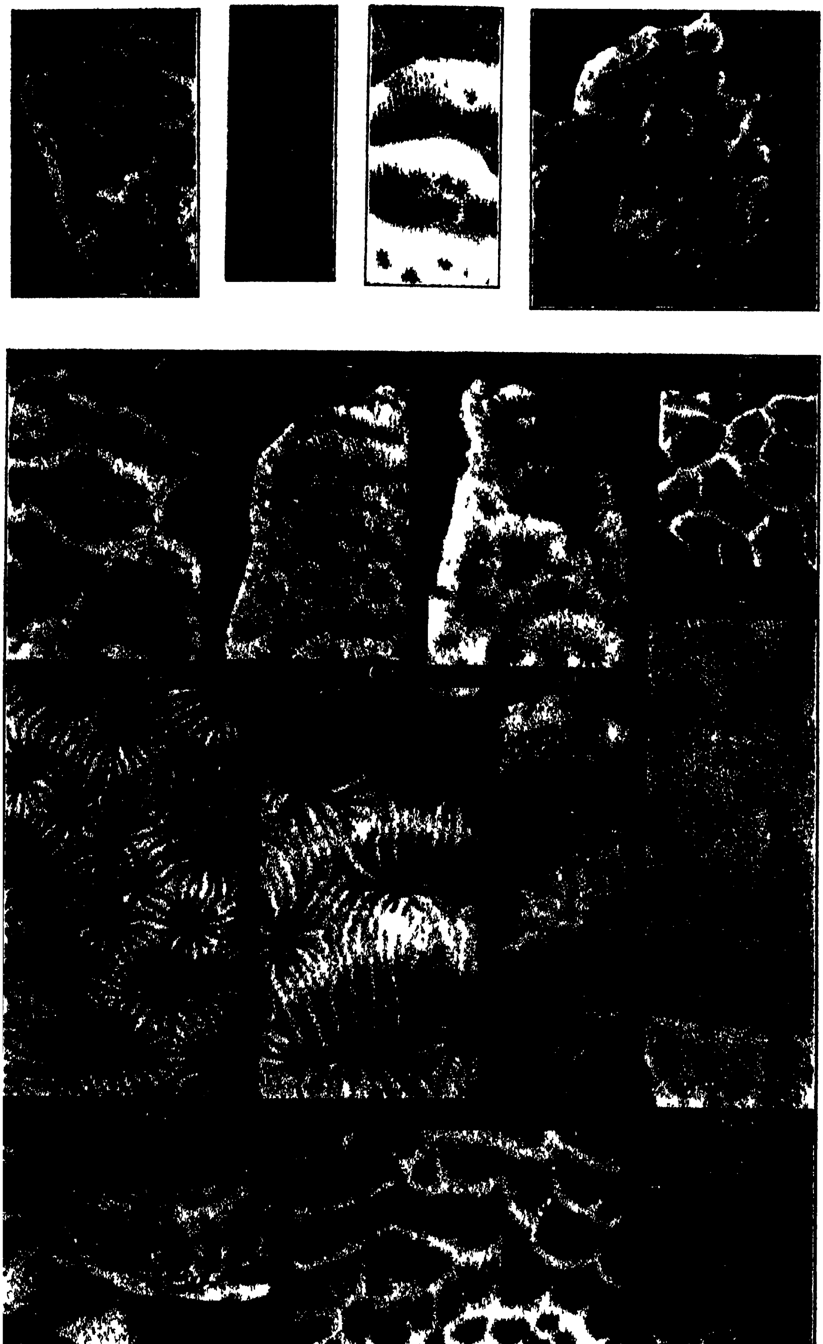

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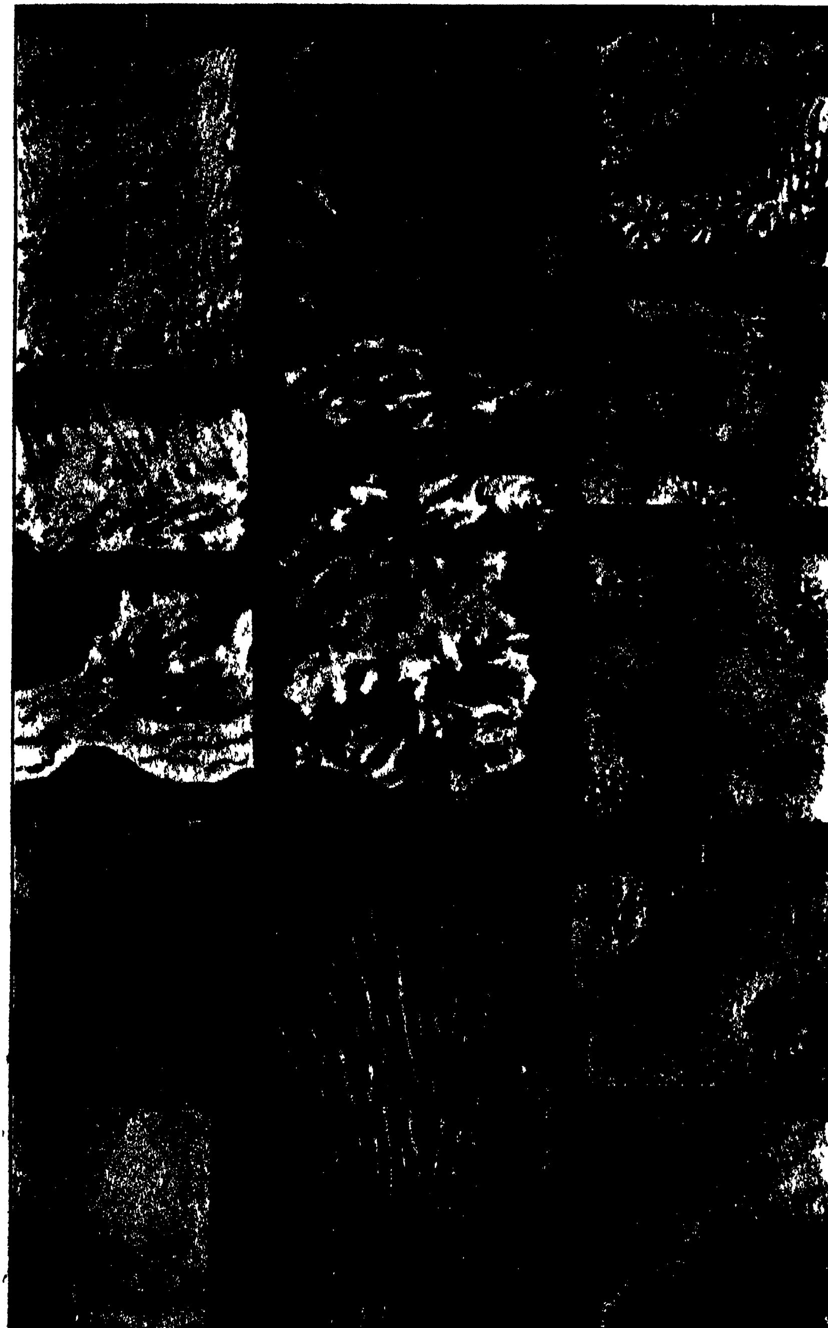

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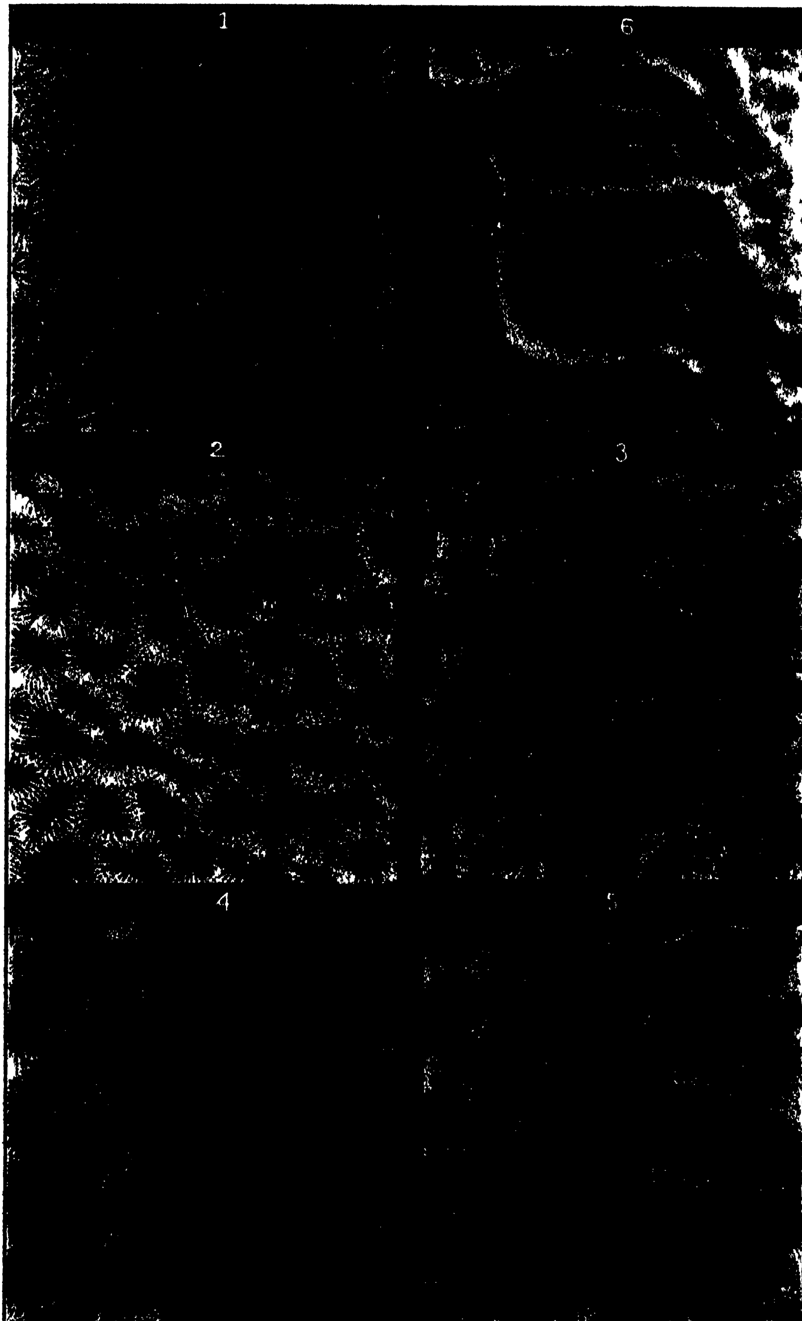

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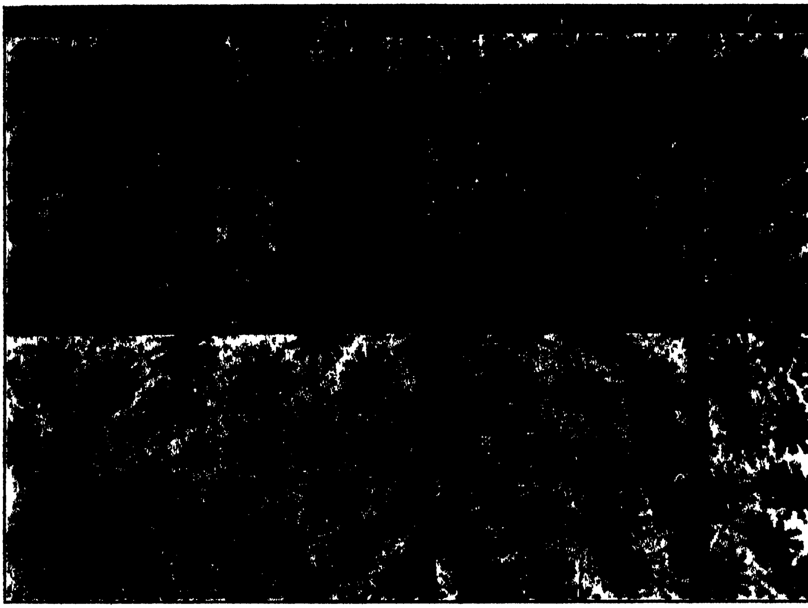

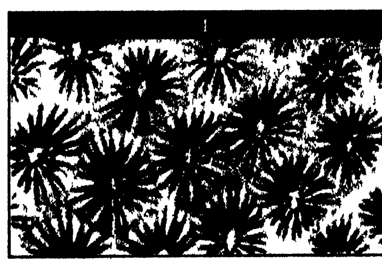

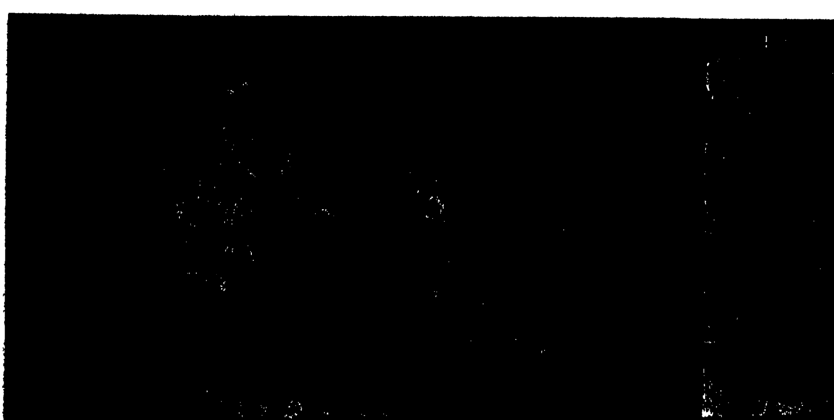

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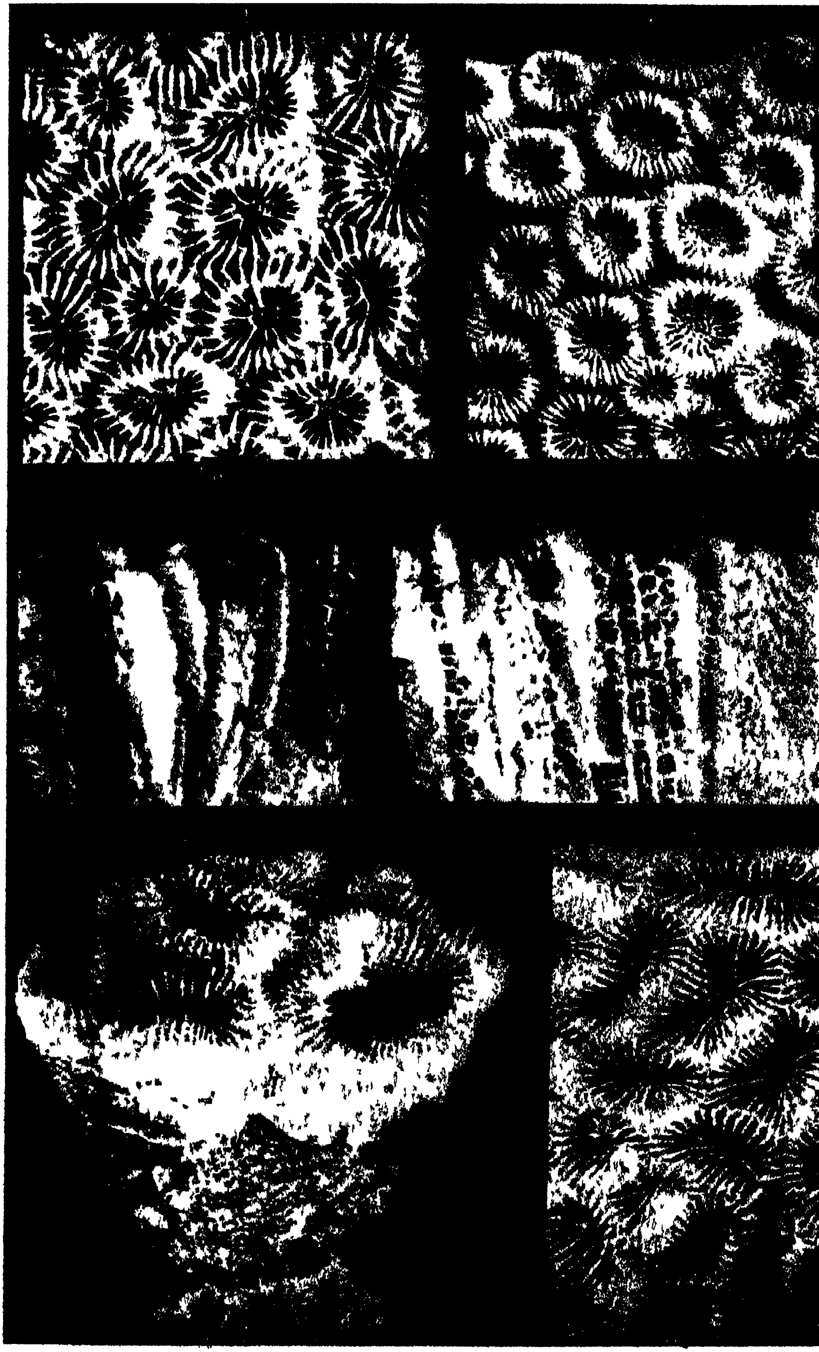
A. H. Verrill, Phot.



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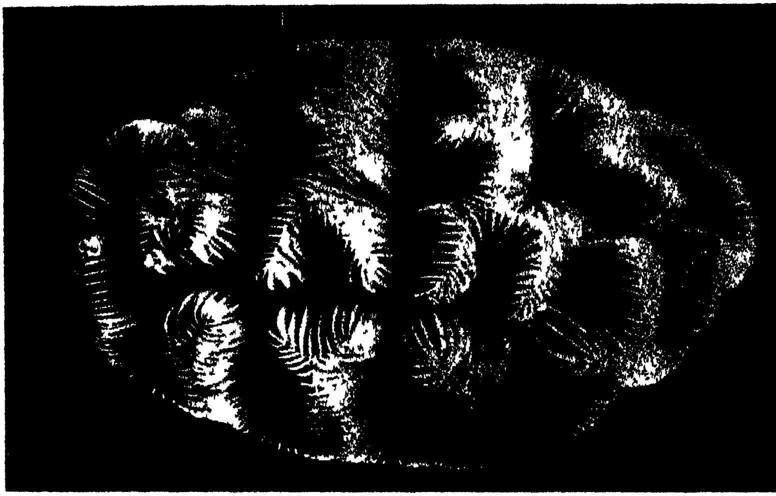

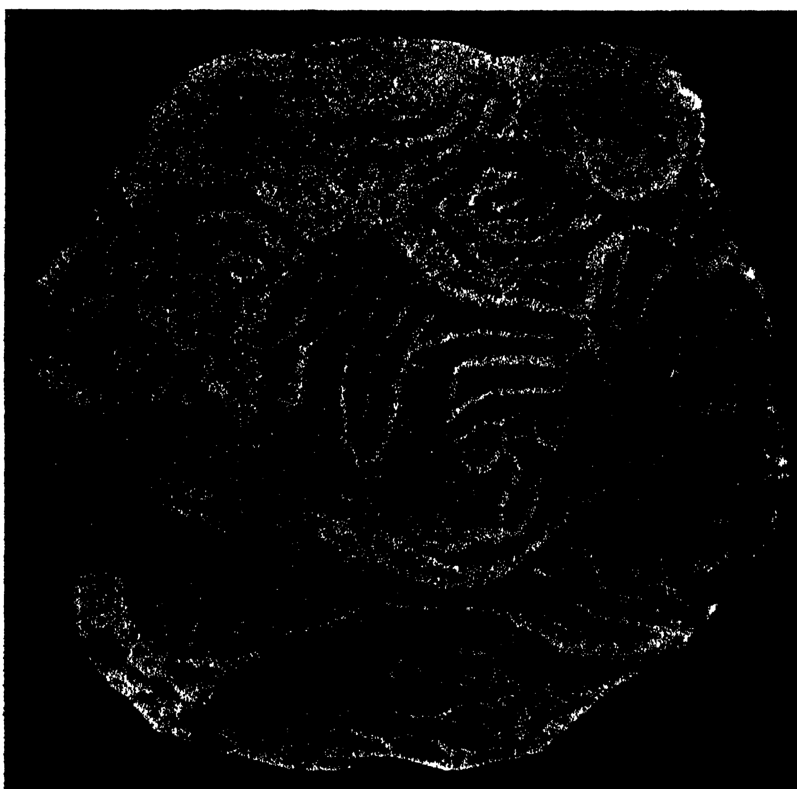

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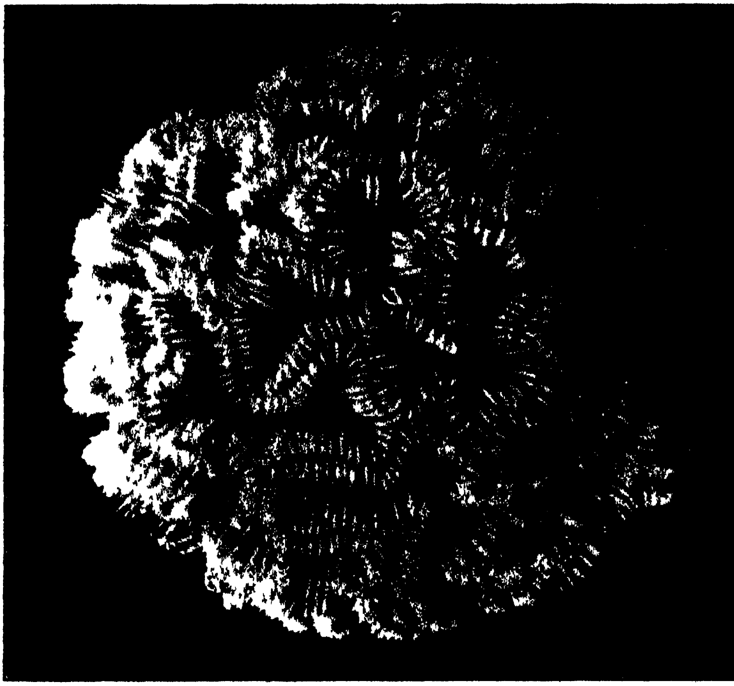

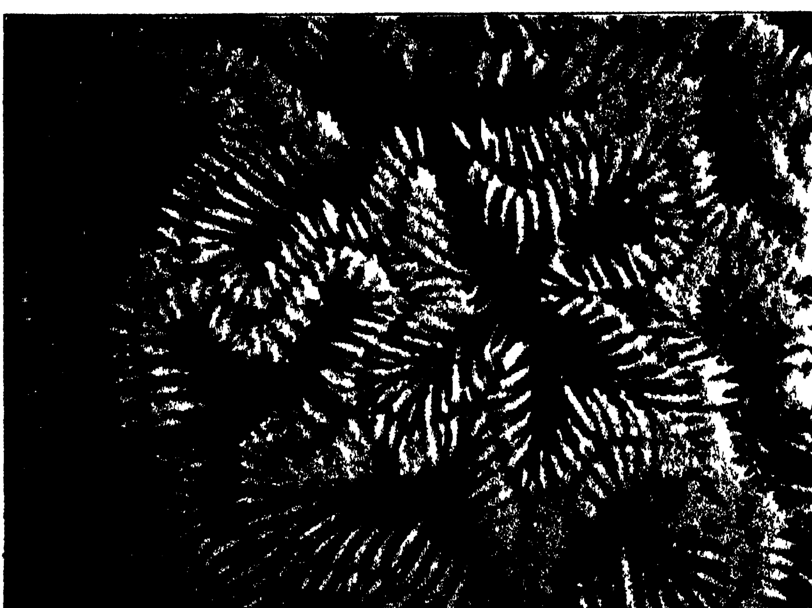

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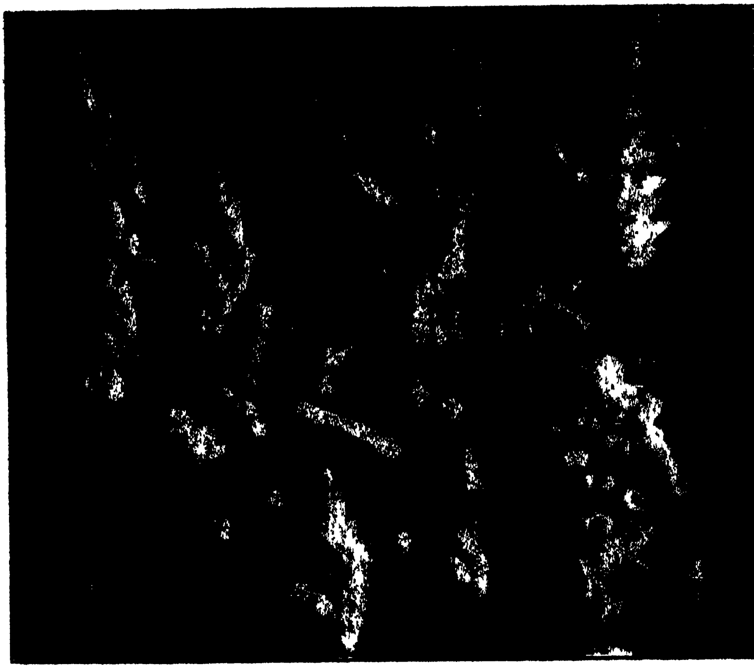

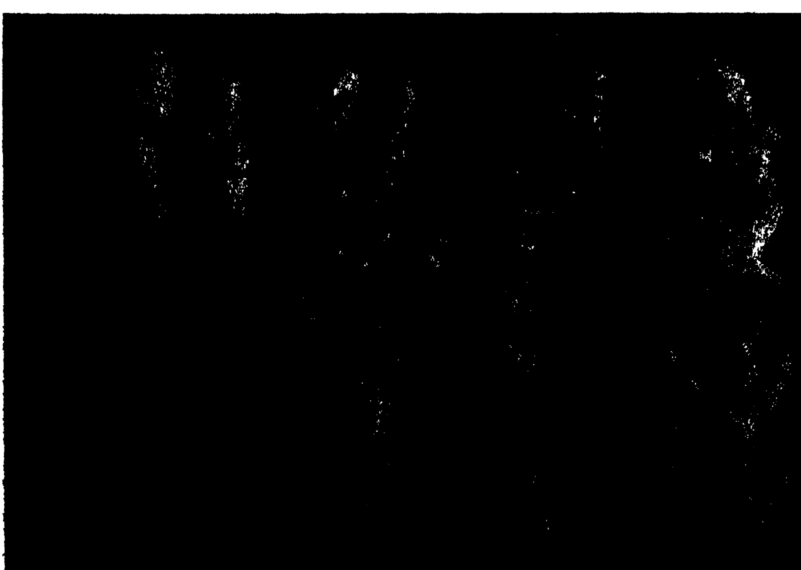

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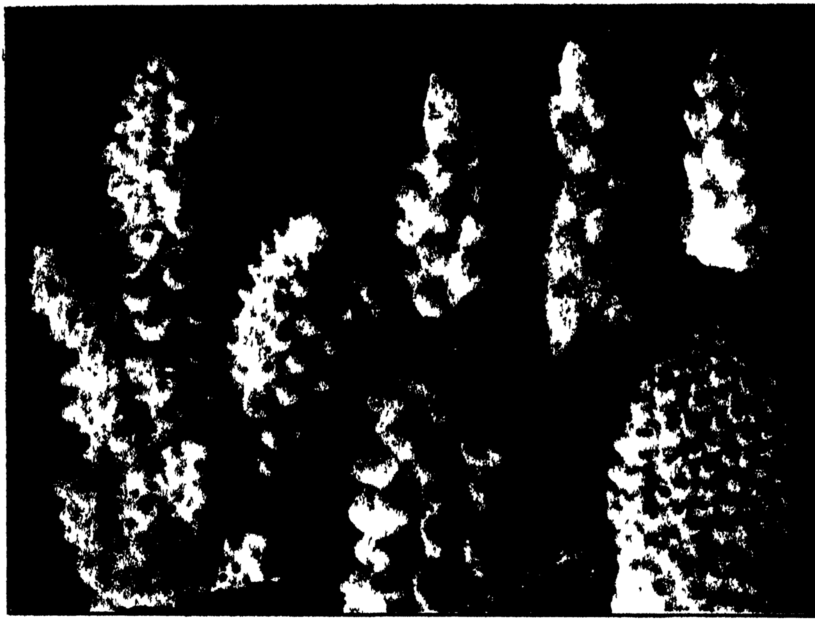

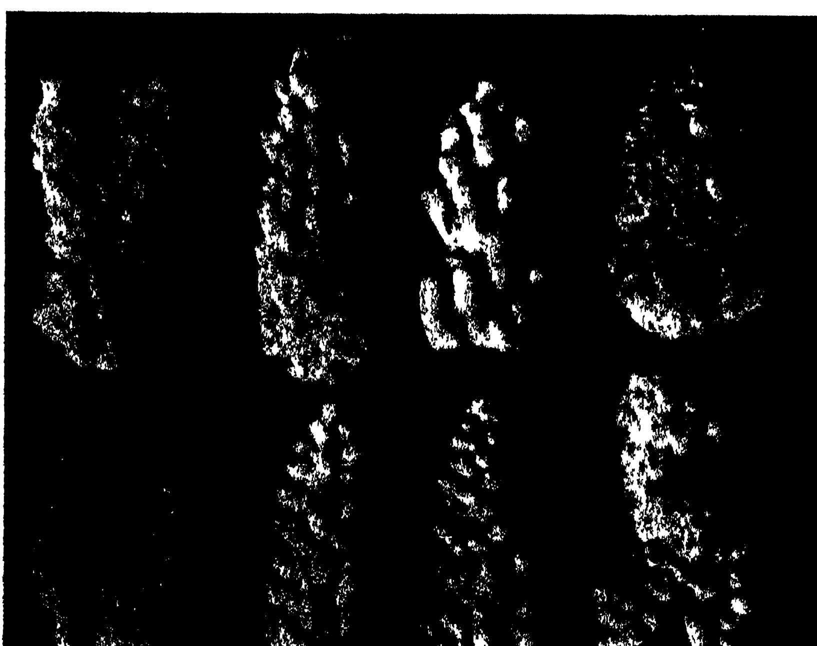

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A. Hyatt Verrill, Phot. Gill Eng. Co.

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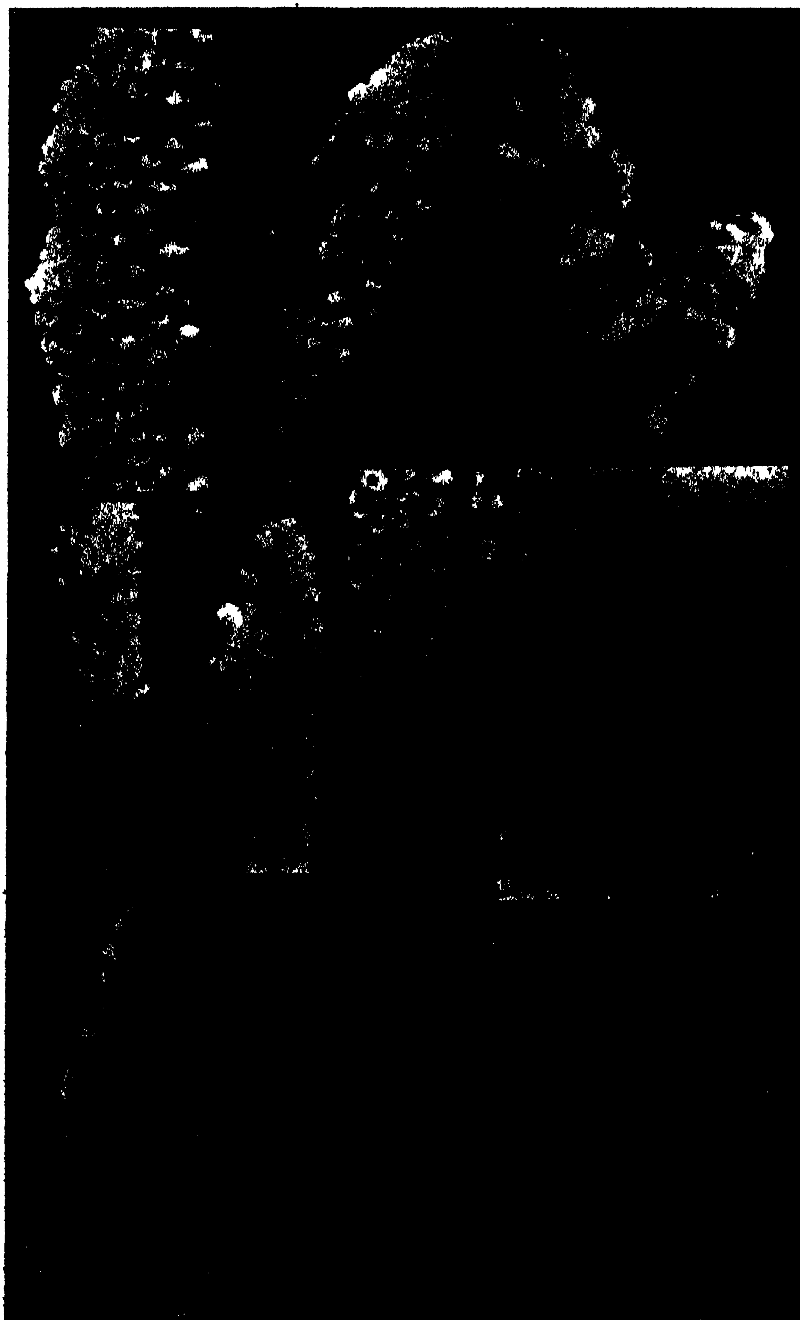

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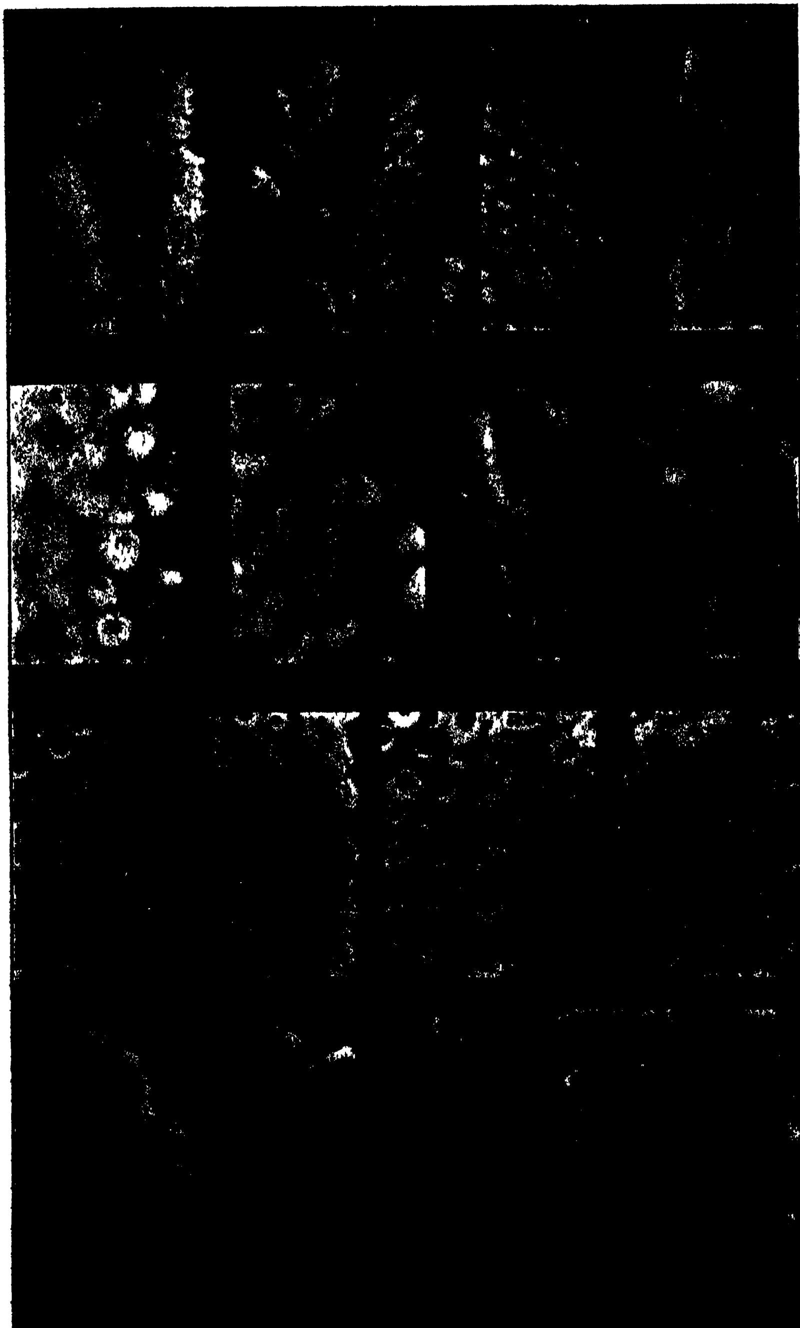

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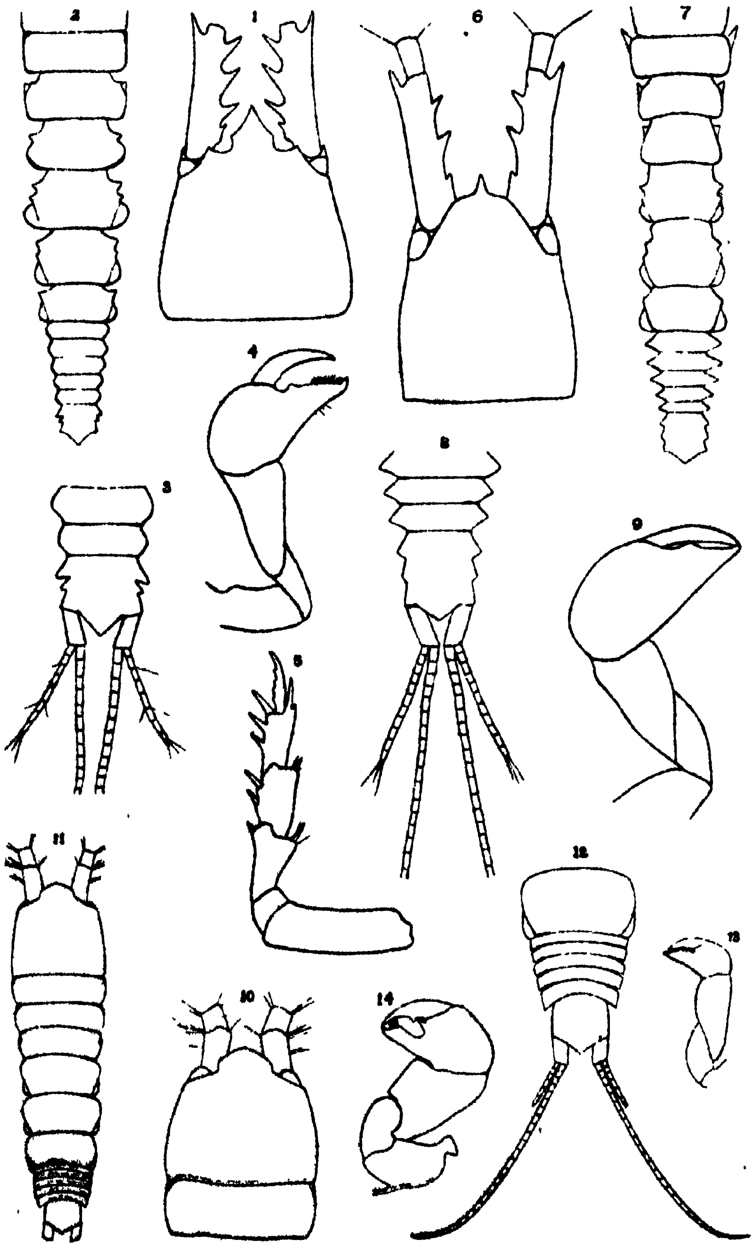
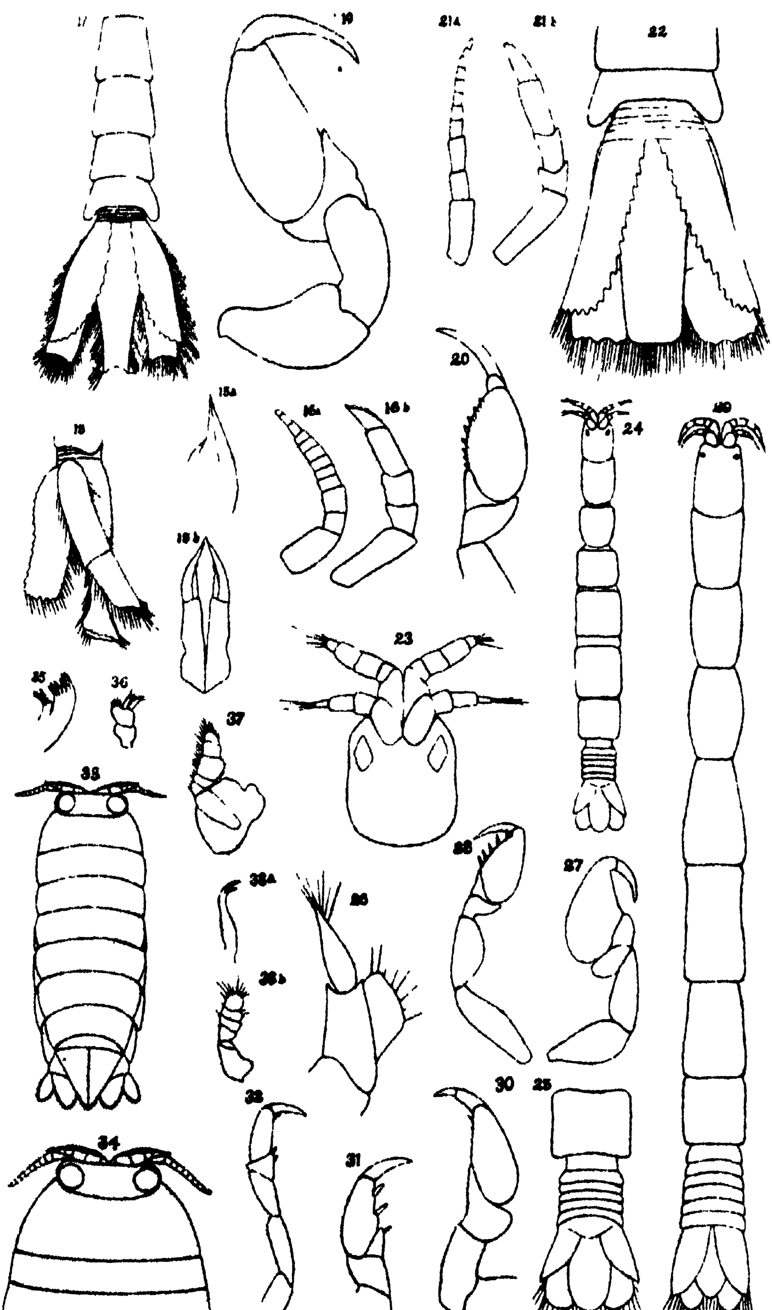
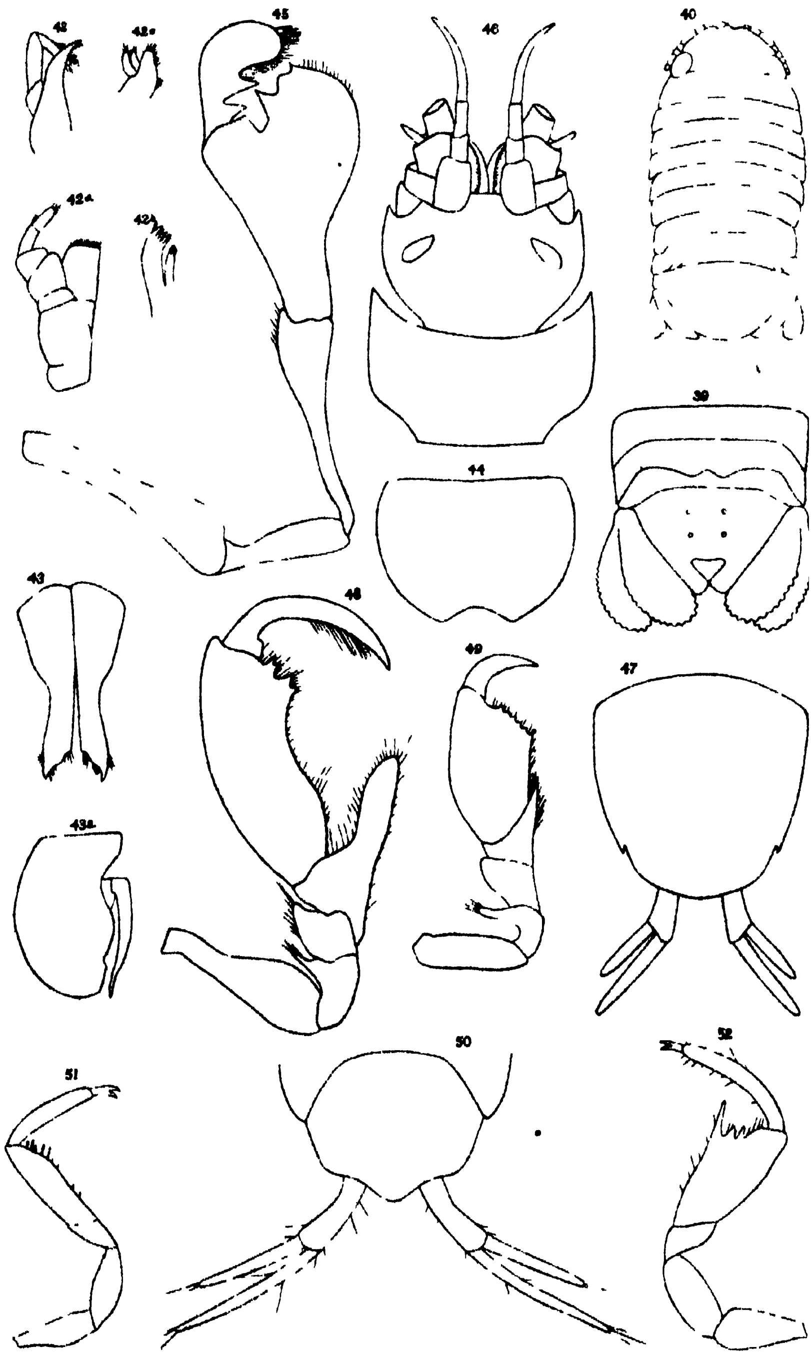


H. Richardson, del. Heliotype Printing Co., Boston



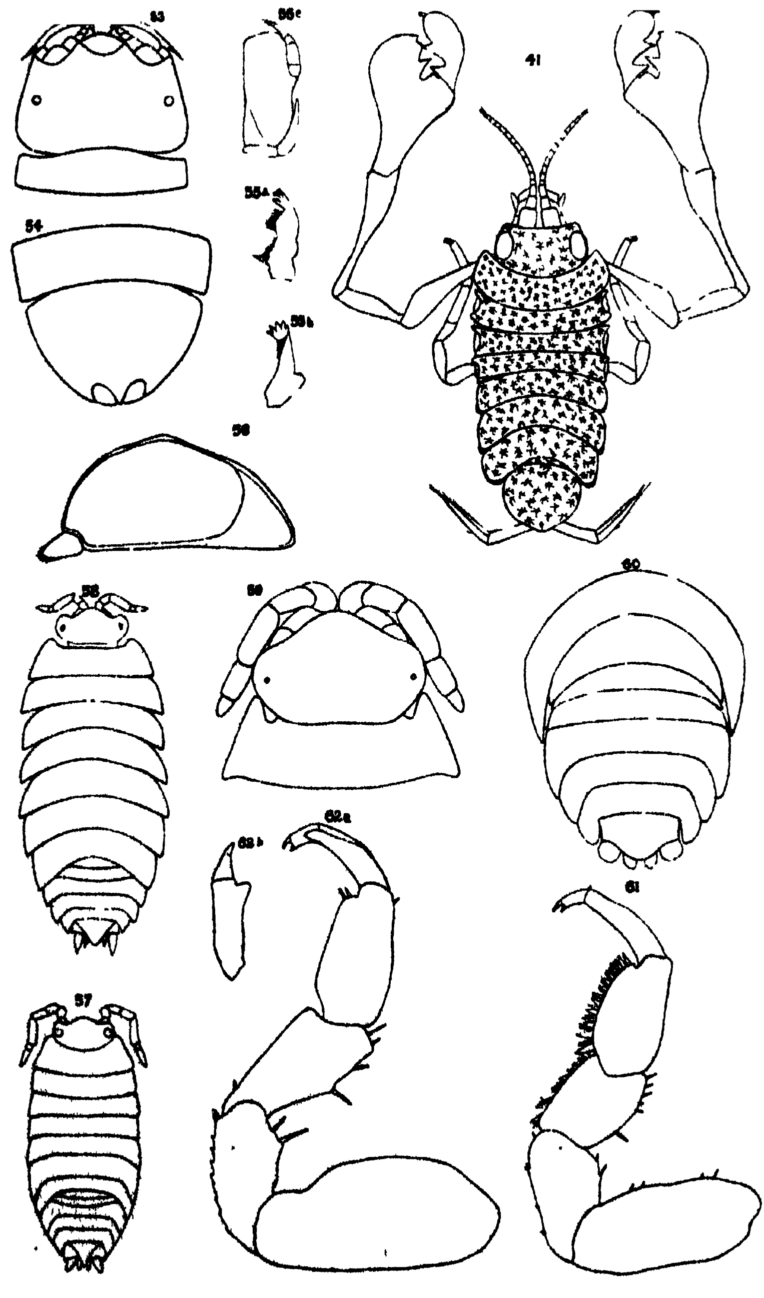
H. Richardson, del.

Heliotype Printing Co. Boston



H Richardson, del

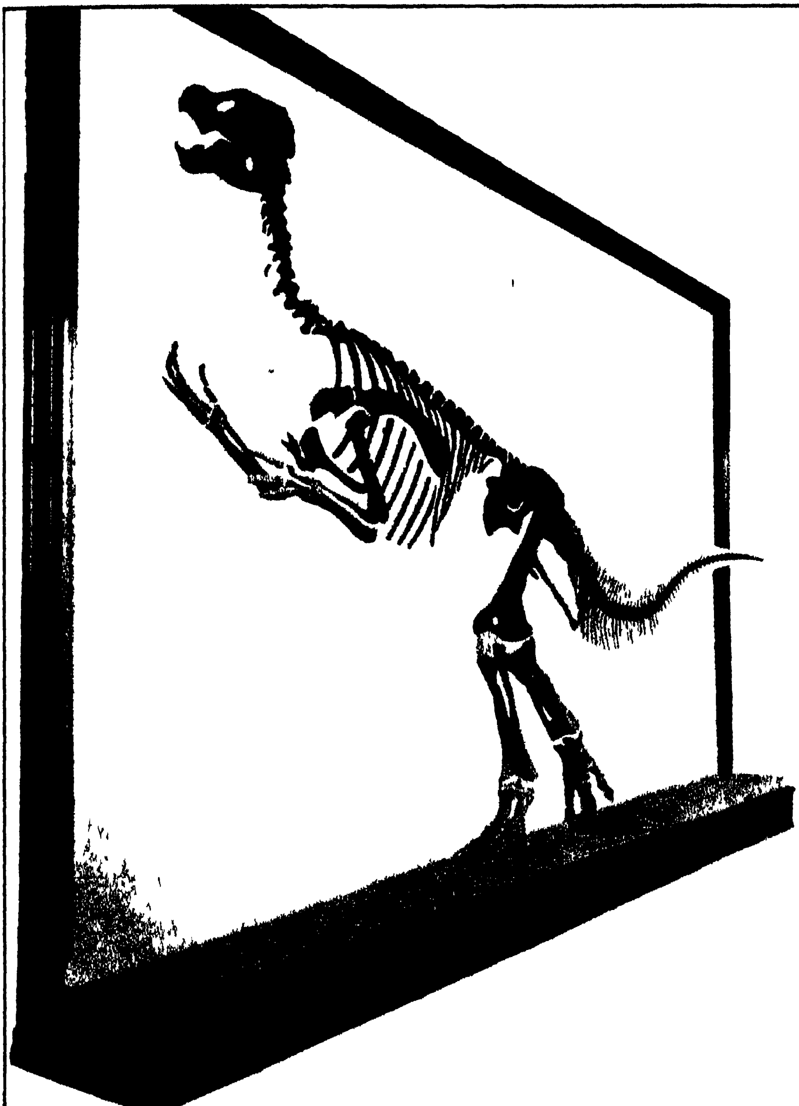
Heliotype Printing Co. Boston



H. Richardson, del.

Heliotype Printing Co., Boston

Claosaurus annectens Marsh 1/40



Claosaurus annectens Marsh

CLAOSAURUS ANNECTENS Marsh. 1/18.

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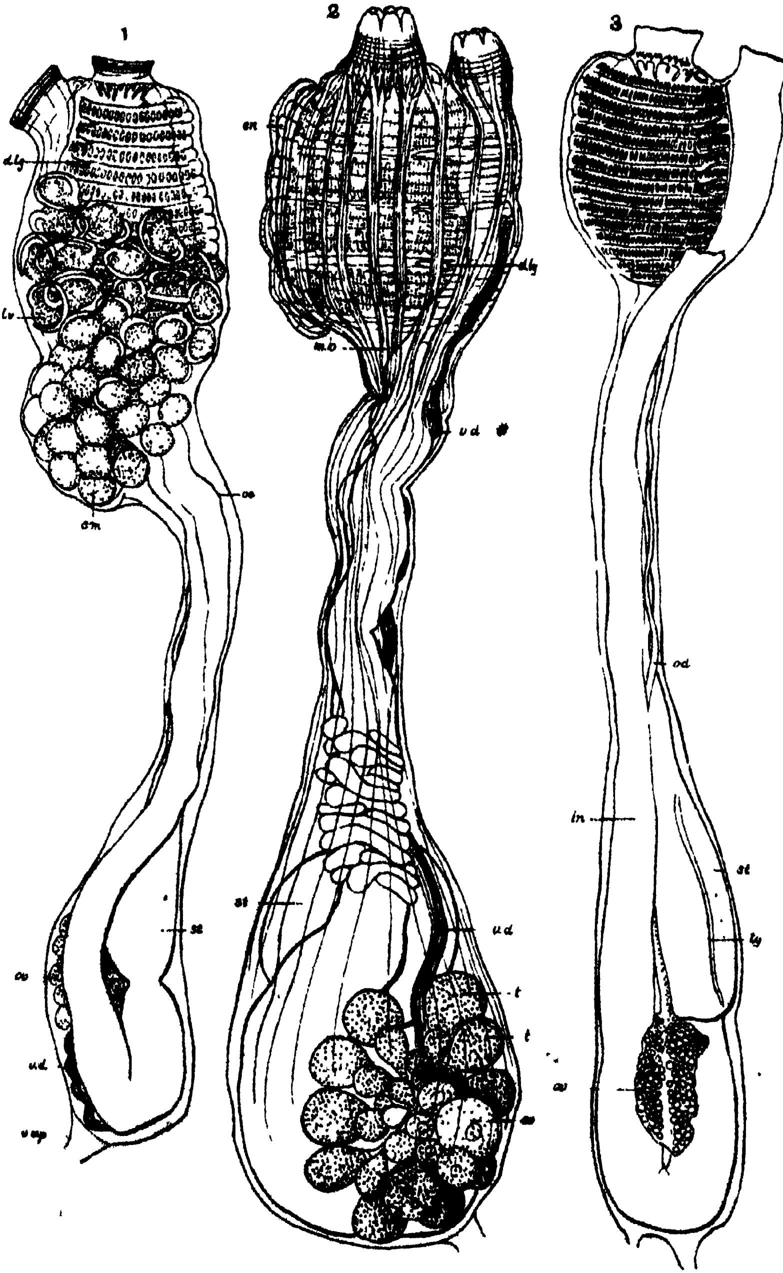
Claosaurus annectens Marsh.

CLAOSAURUS ANNECTENS Marsh.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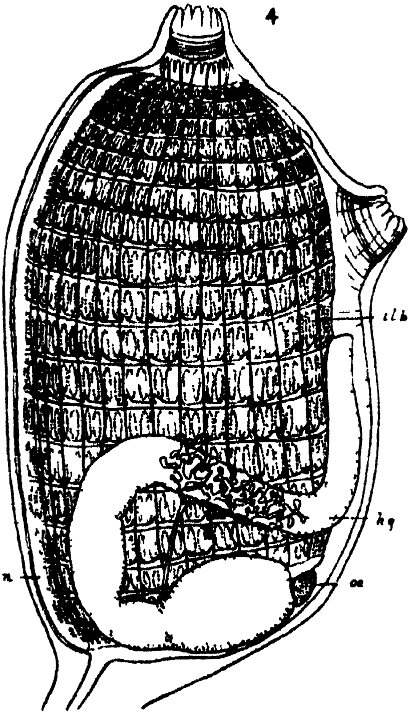

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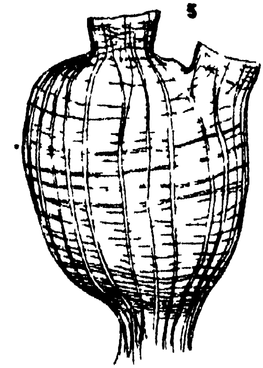

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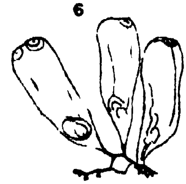

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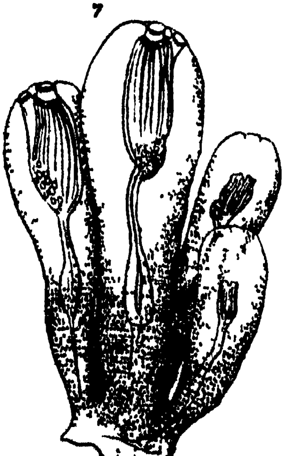

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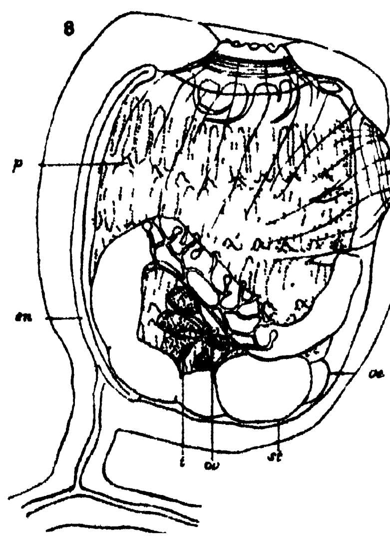

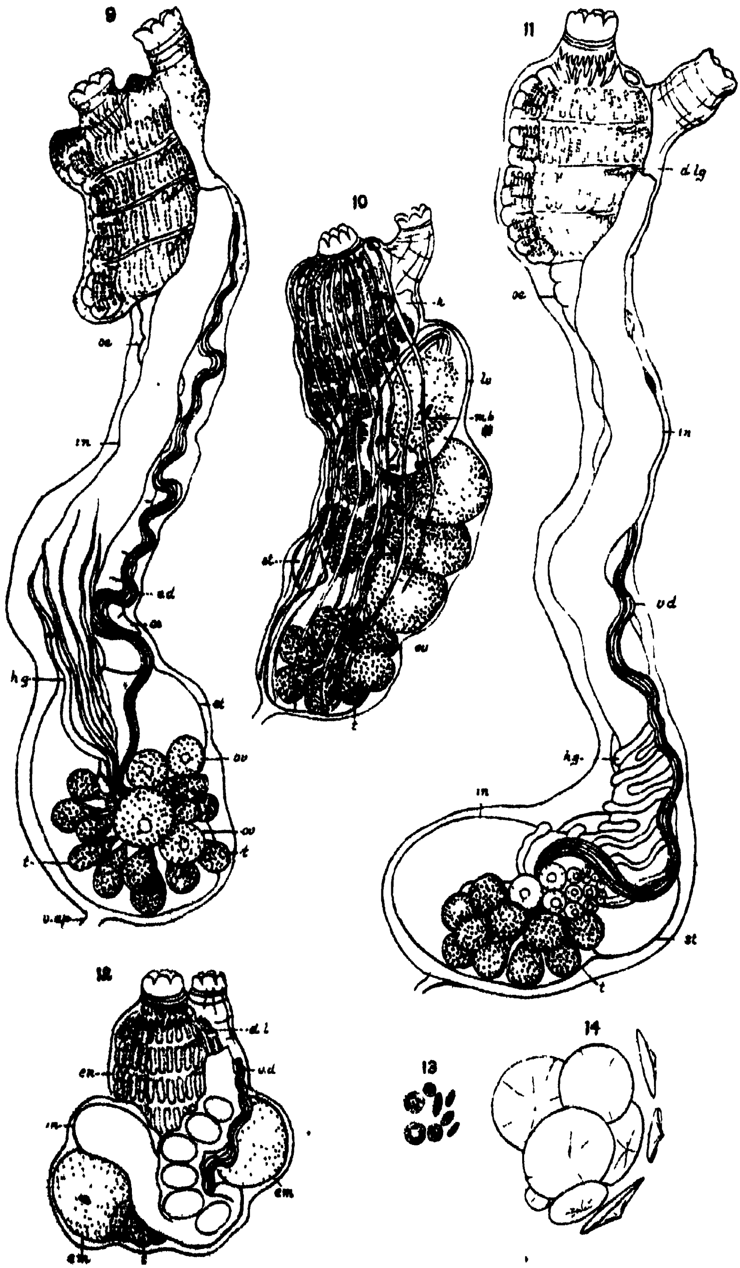

W. G. Van Name, del. Heliotype Printing Co. Boston

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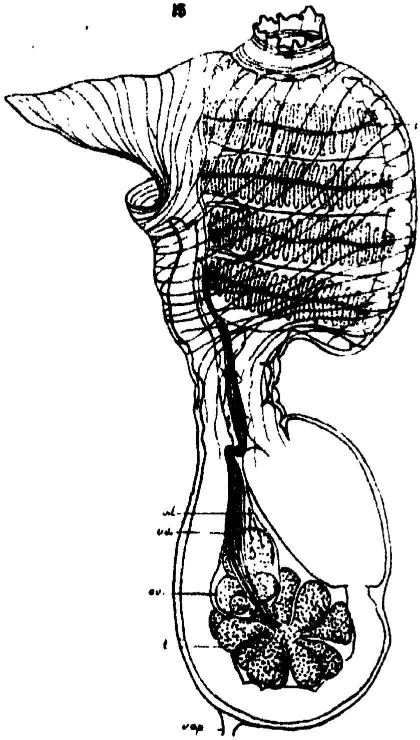

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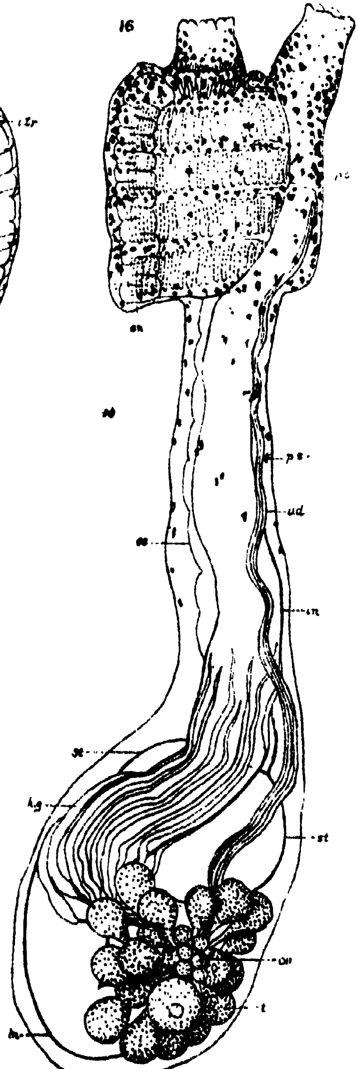

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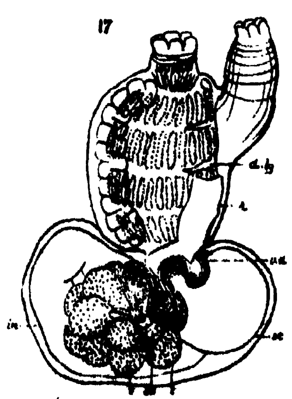

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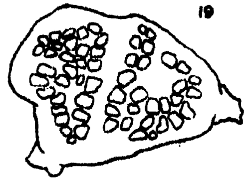

W. G. Van Name, del. Heliotype Printing Co. Boston

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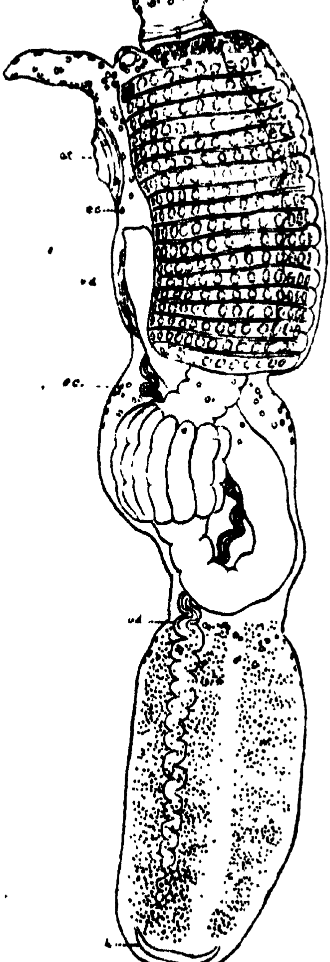

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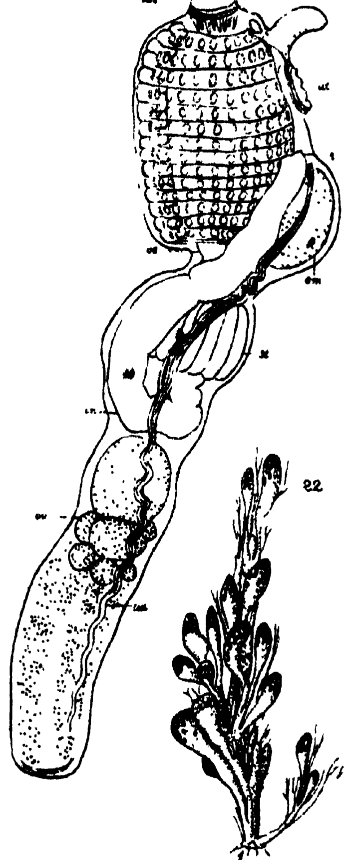

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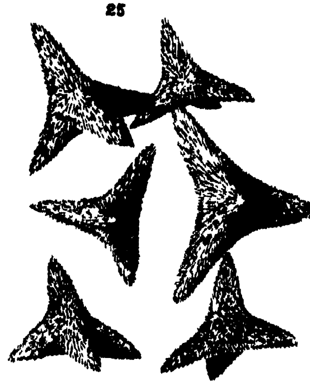

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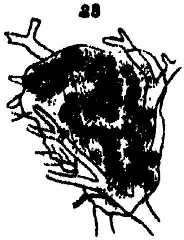

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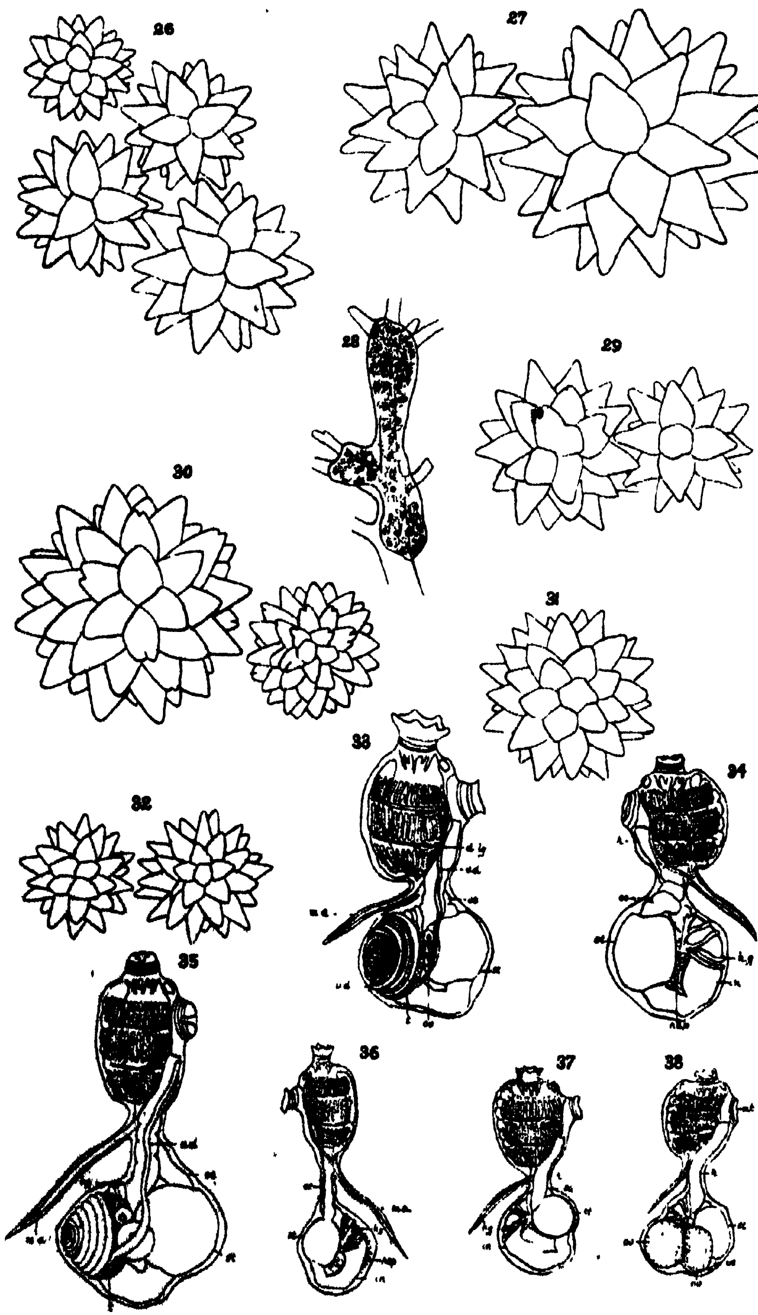
W G Van Name, del.

Heliotype Printing Co. Boston



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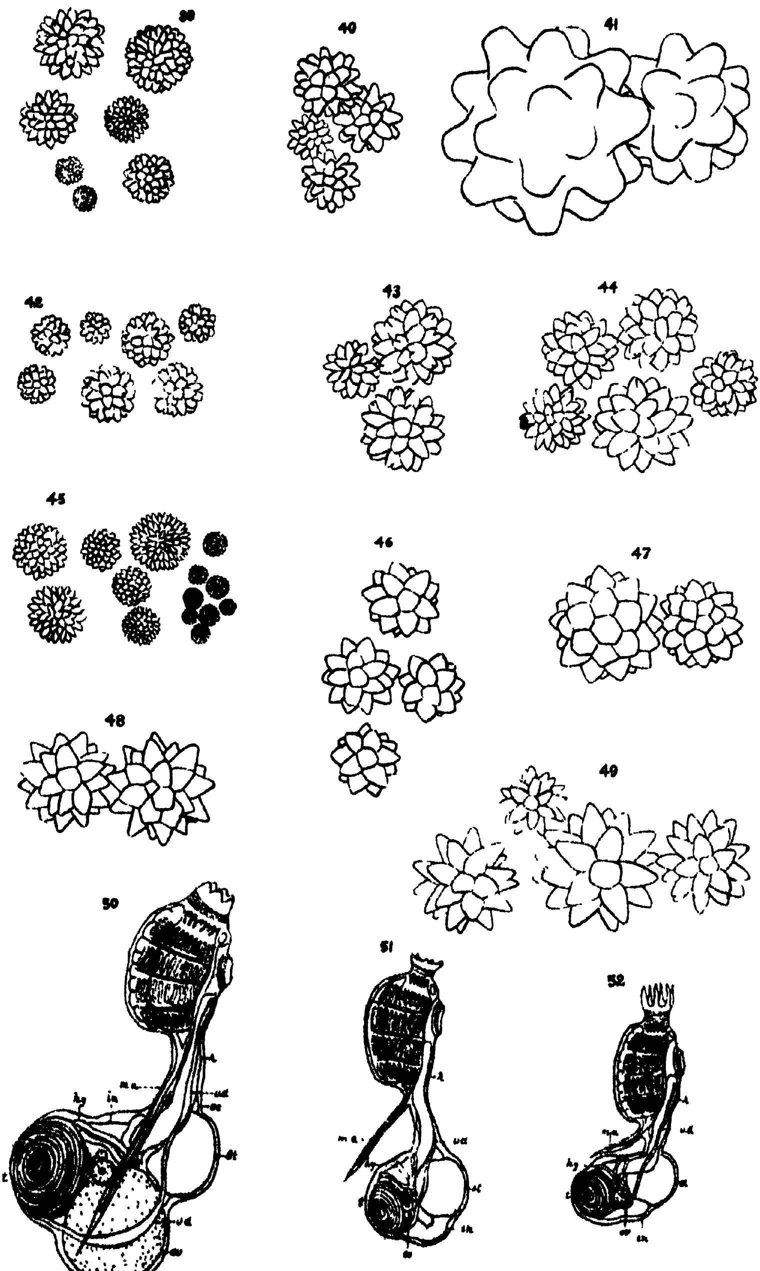
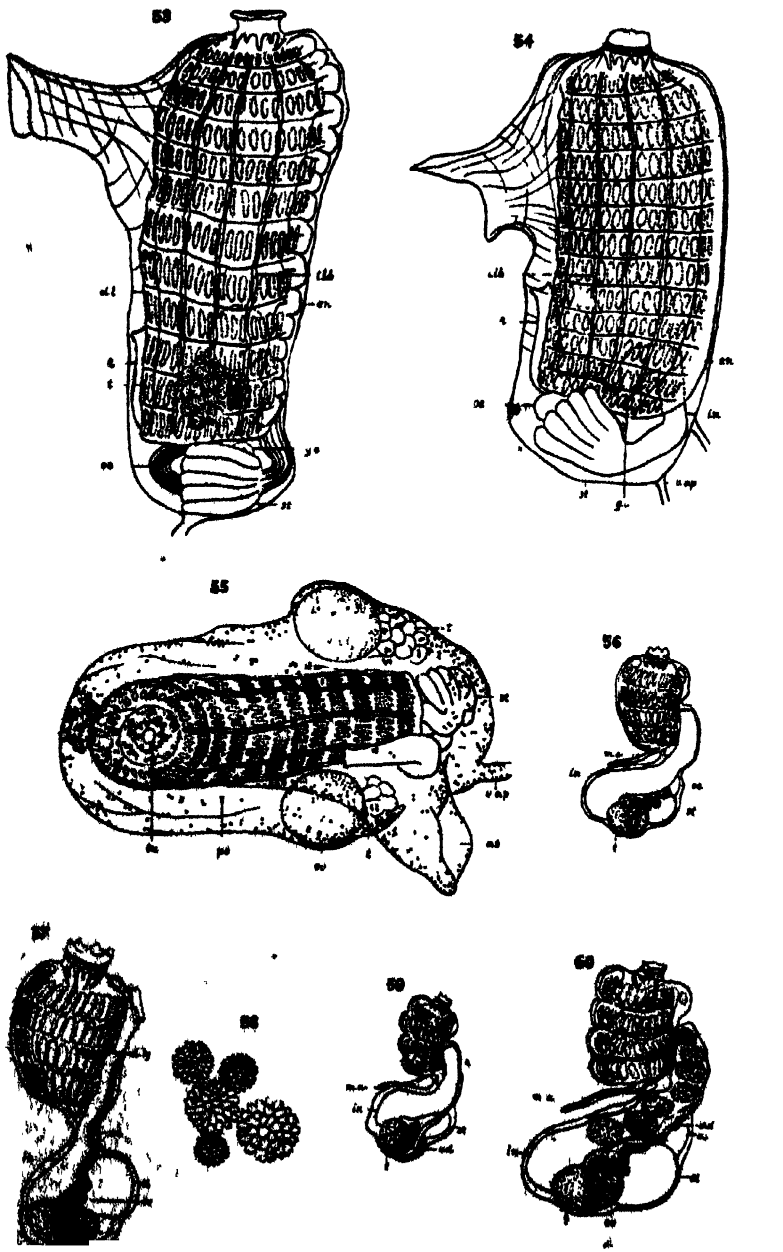


W. G. Van Name, del. Heliotype Printing Co. Boston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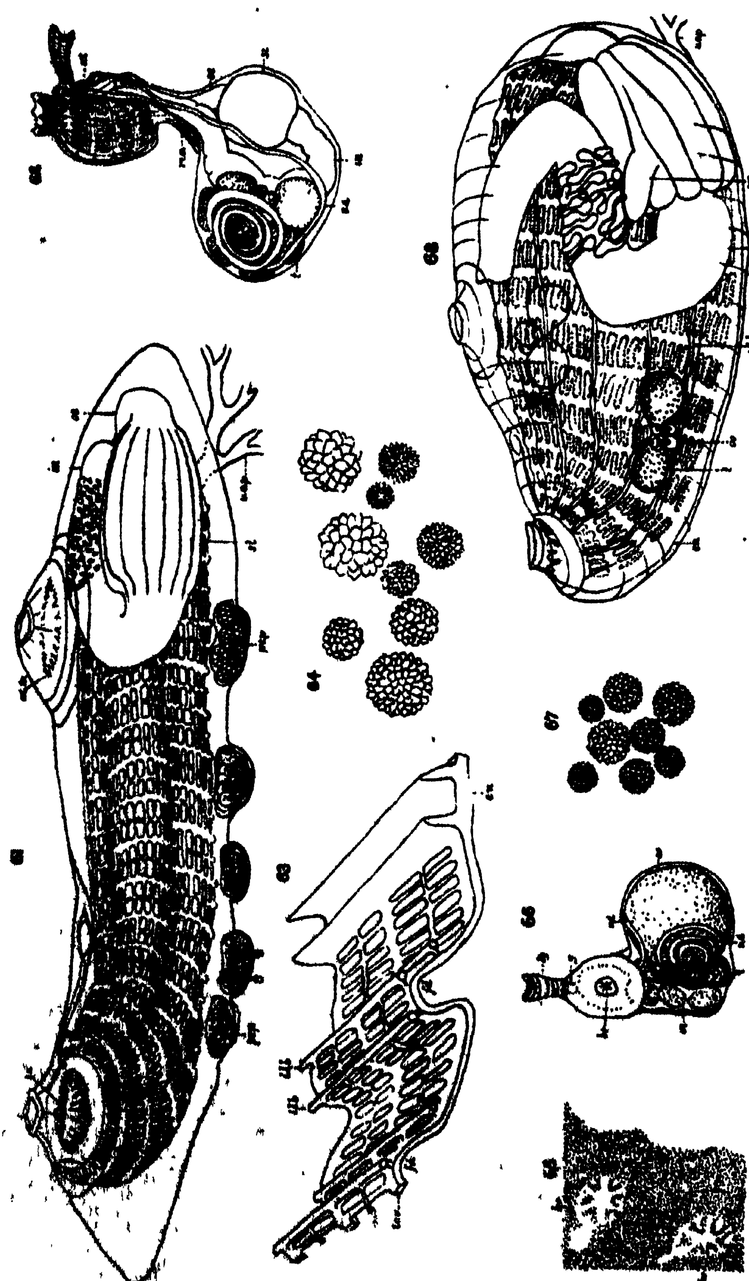
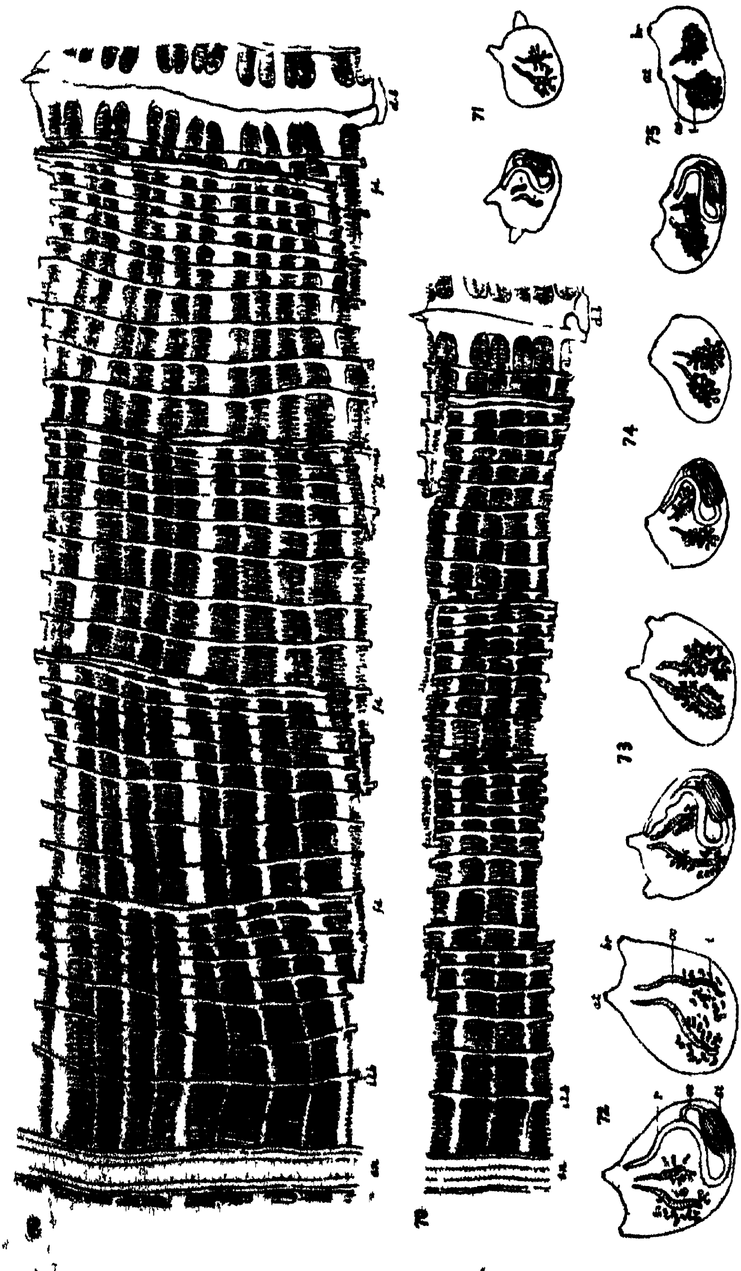
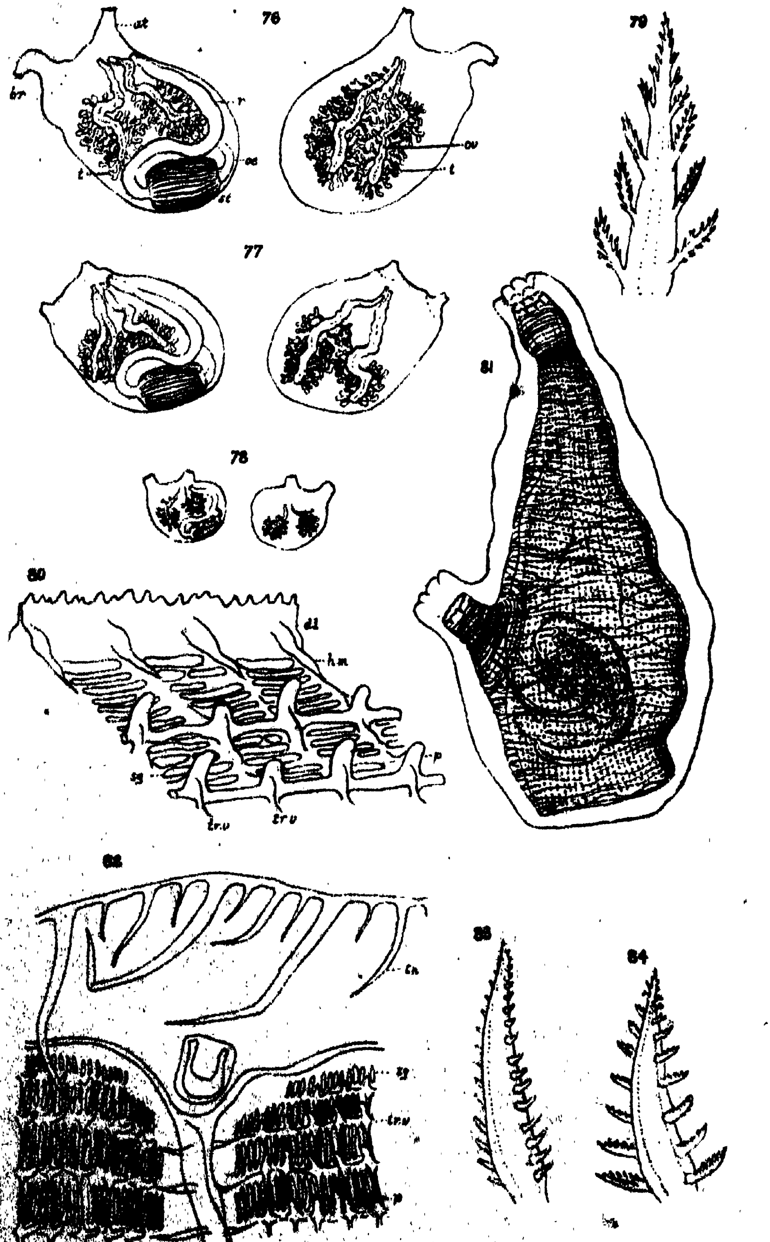


Heliotype Printing Co. Boston



Heliotype Printing Co Boston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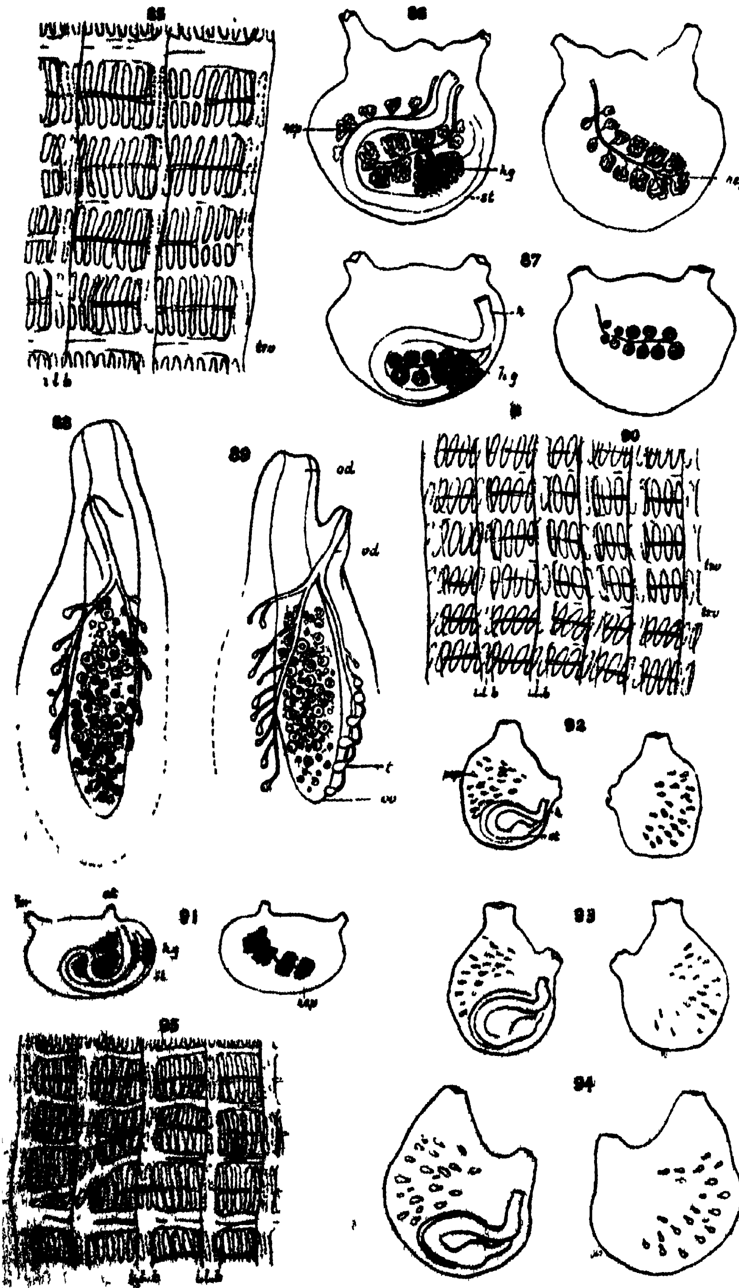
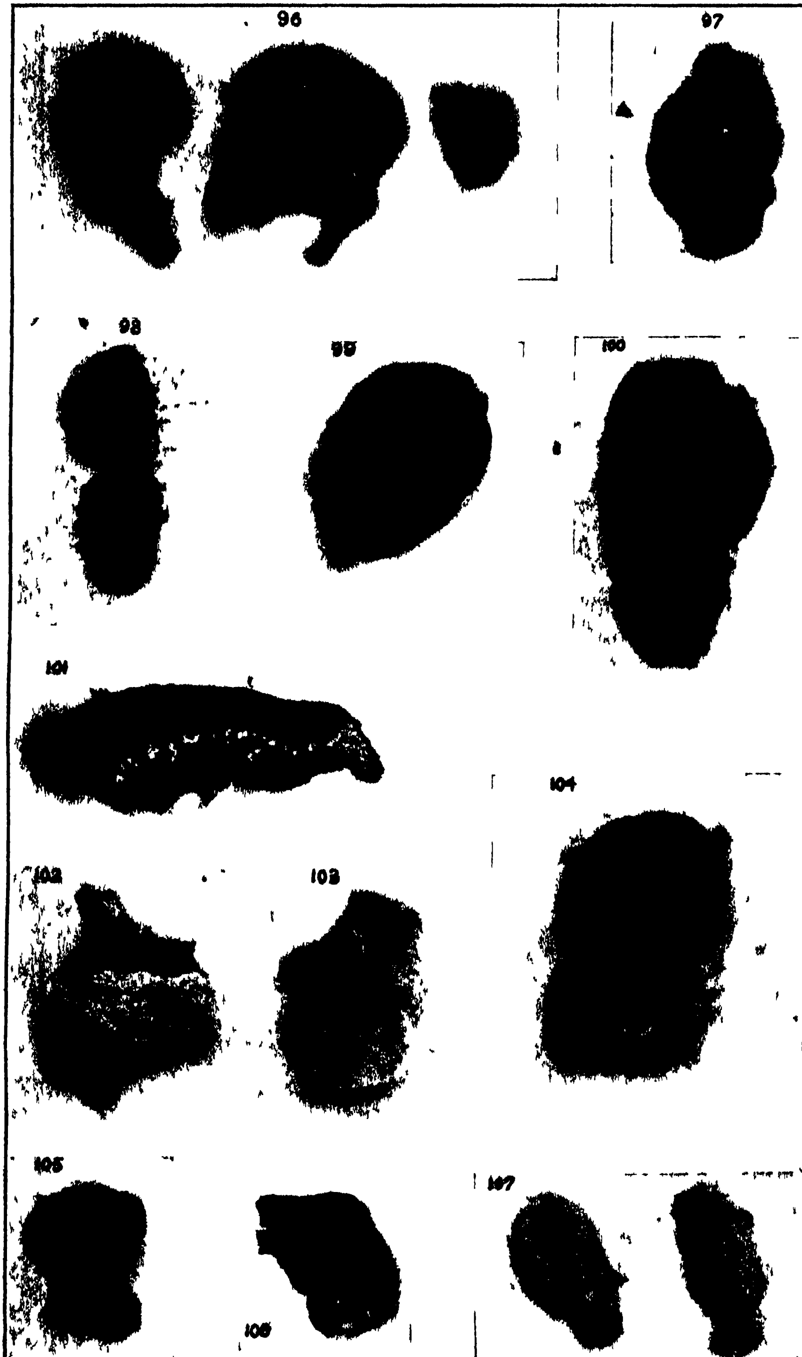


Heliotype Printing Co. Boston.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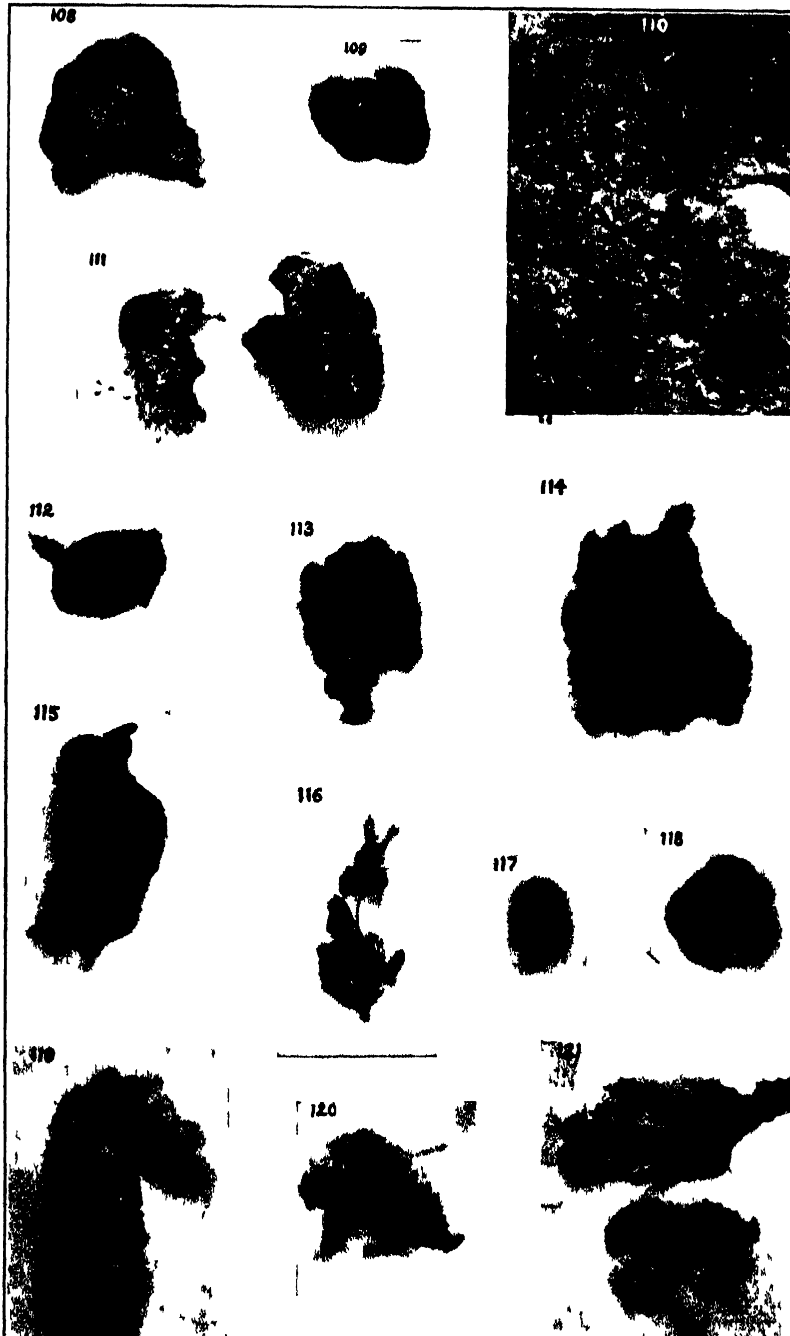
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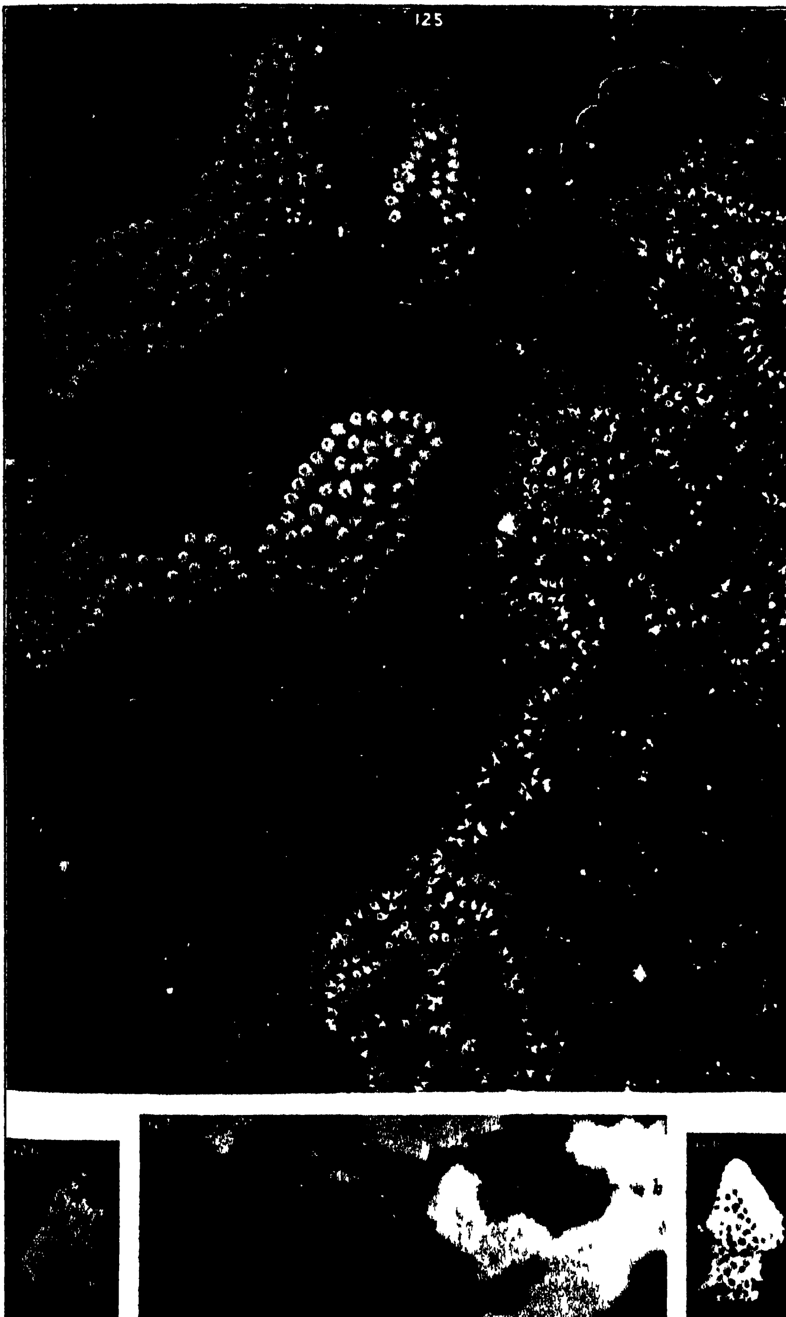
A. Hyatt Verrill, Photo.



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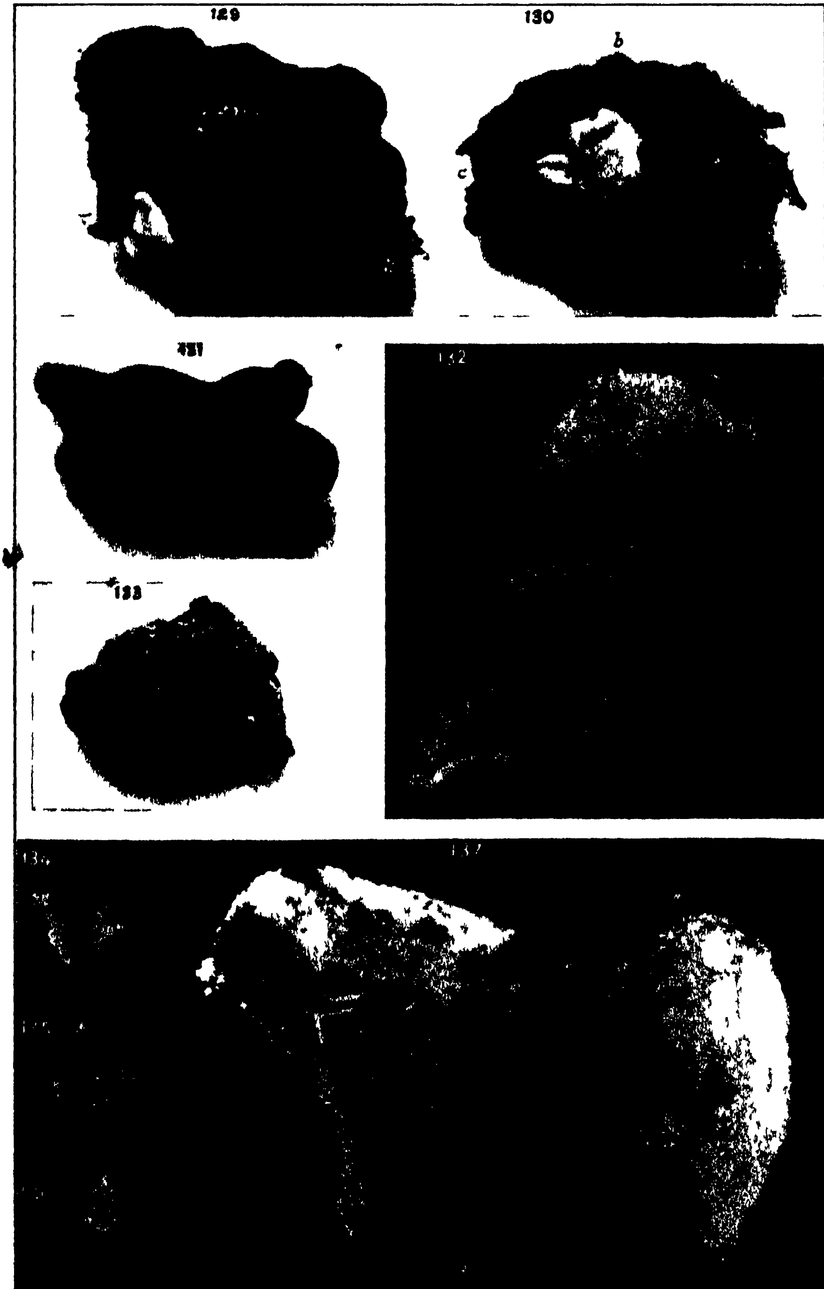
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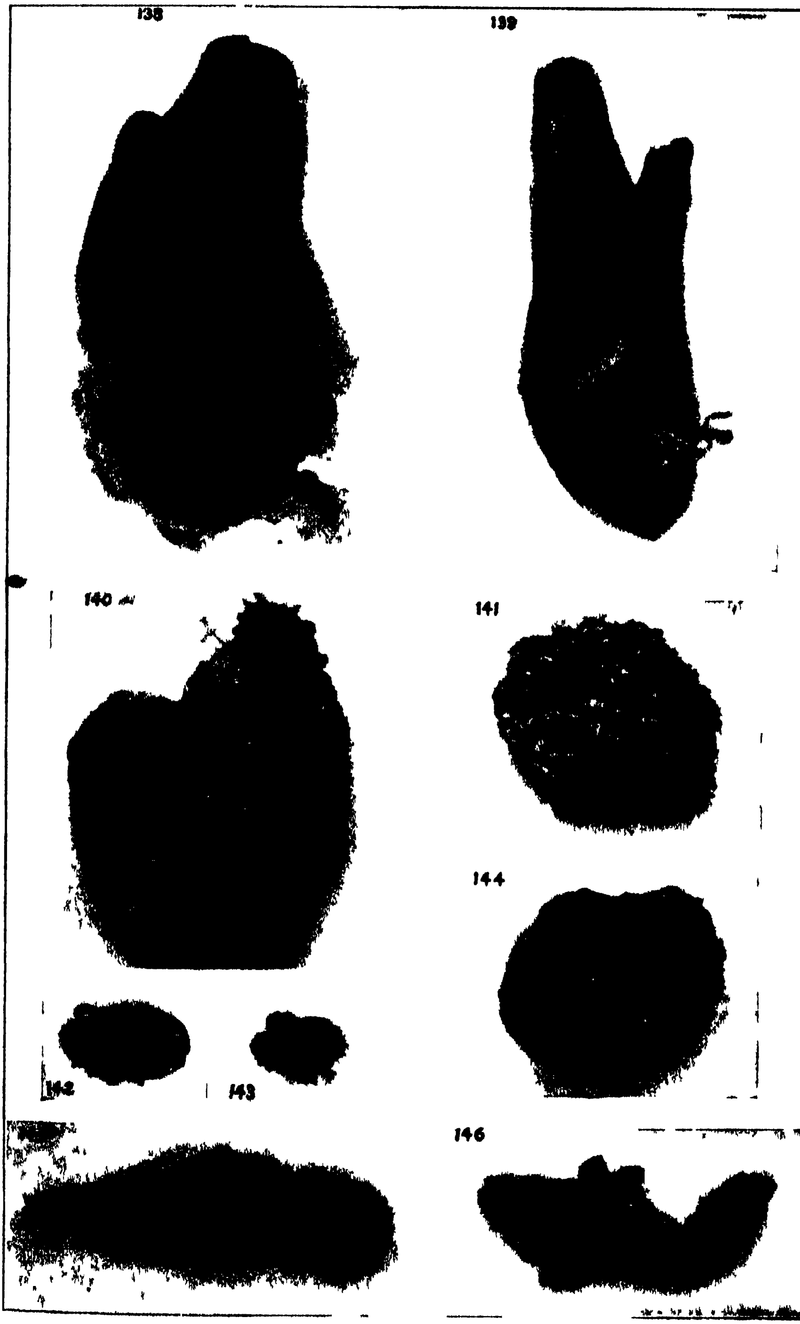
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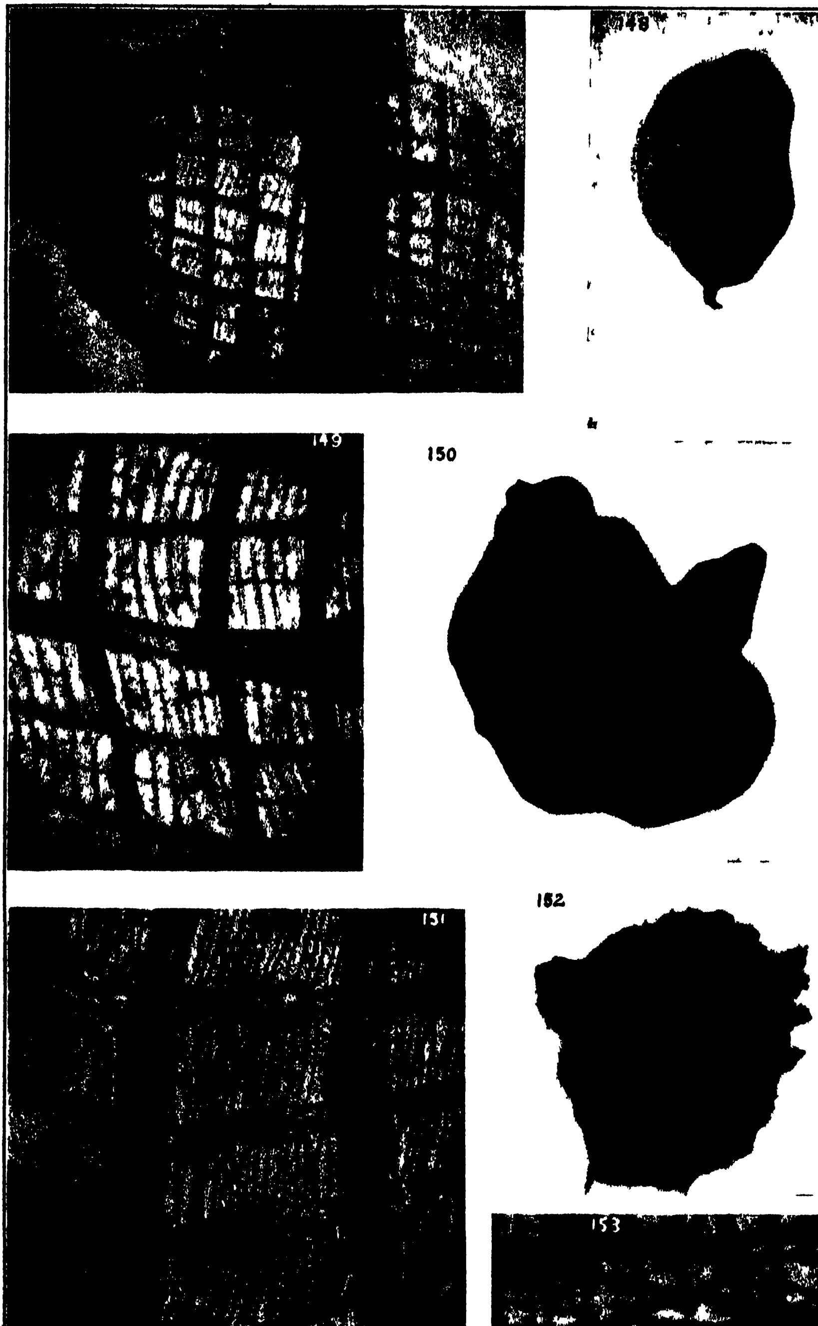

A. Hyatt Verrill, Photo

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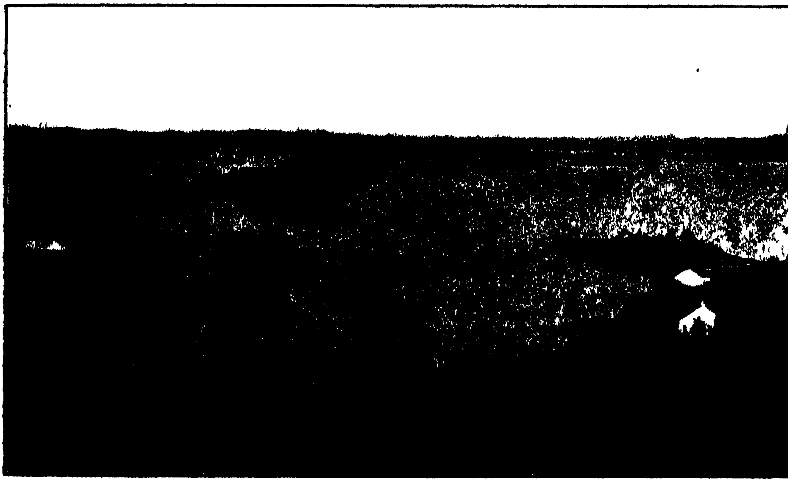

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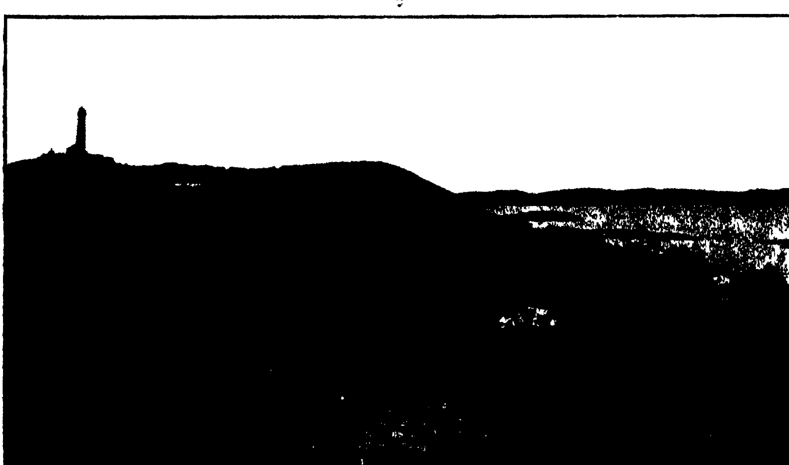

Gill Eng. Co.

GREAT SOUND; GIBBS HILL LIGHT.

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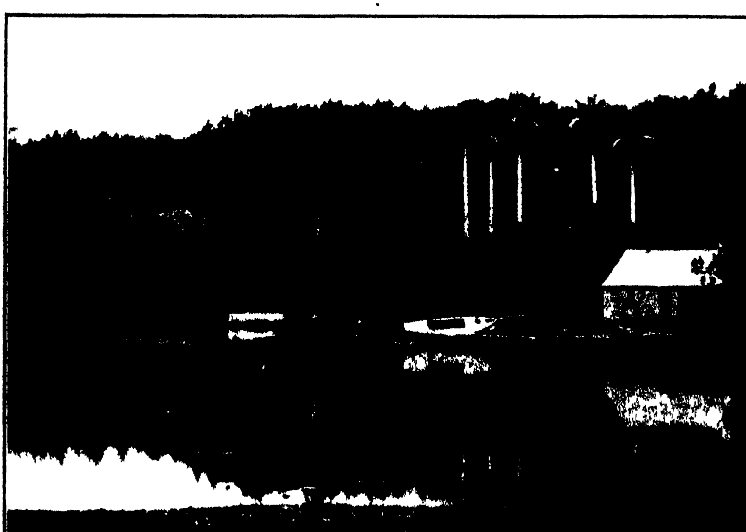

Gill Eng. Co.

HAMILTON HARBOR, ROYAL PALMS

A. Hyatt Verrill, Phot. Gill Eng. Co.

PALMETTO AND BAMBOO.

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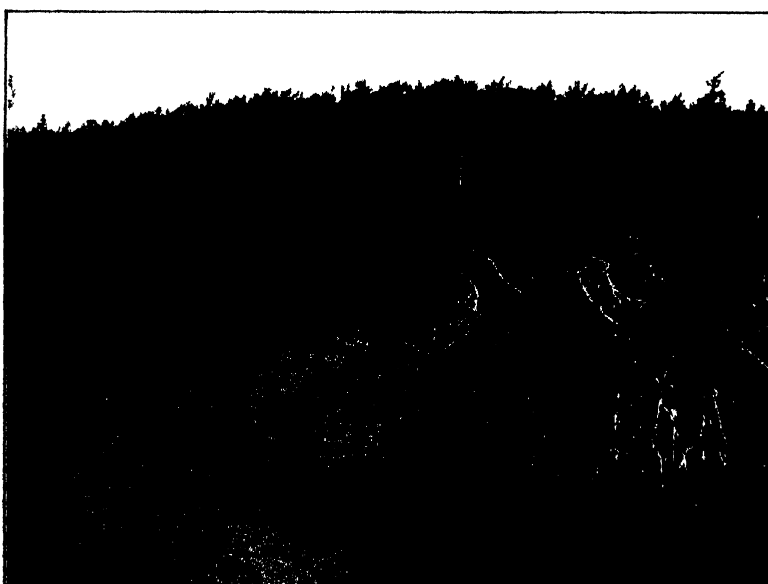
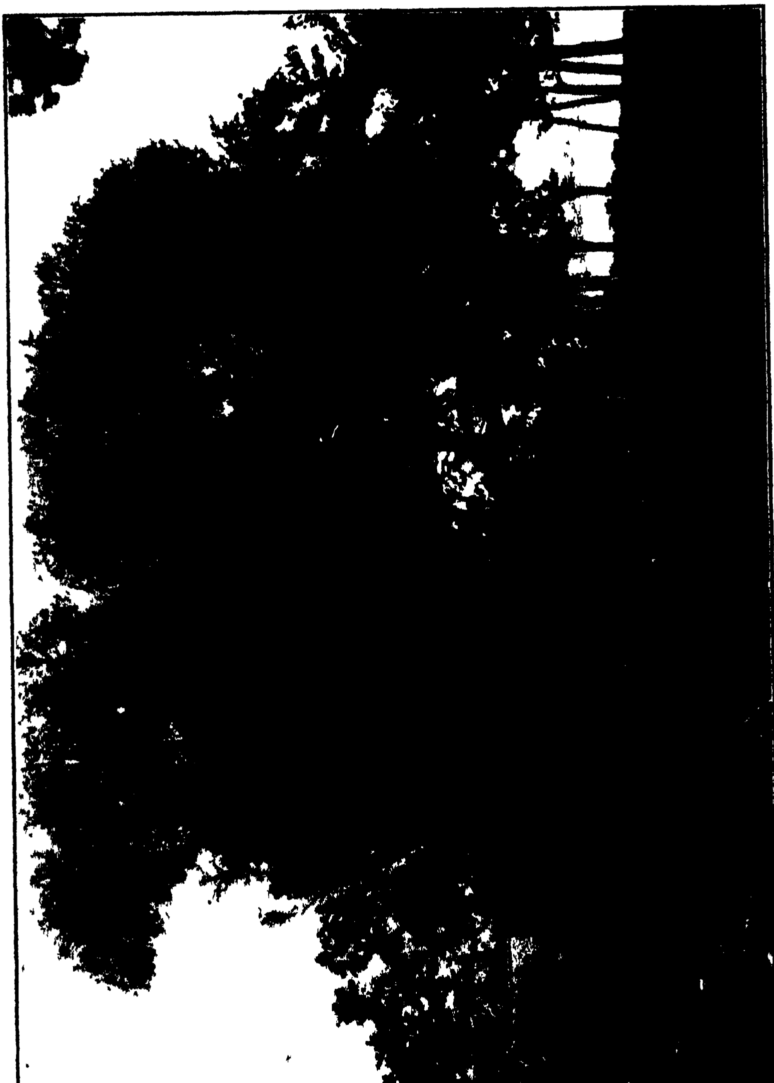


A. Hyatt Verrill and W. G. VanName, Phot Gill Eng. Co.

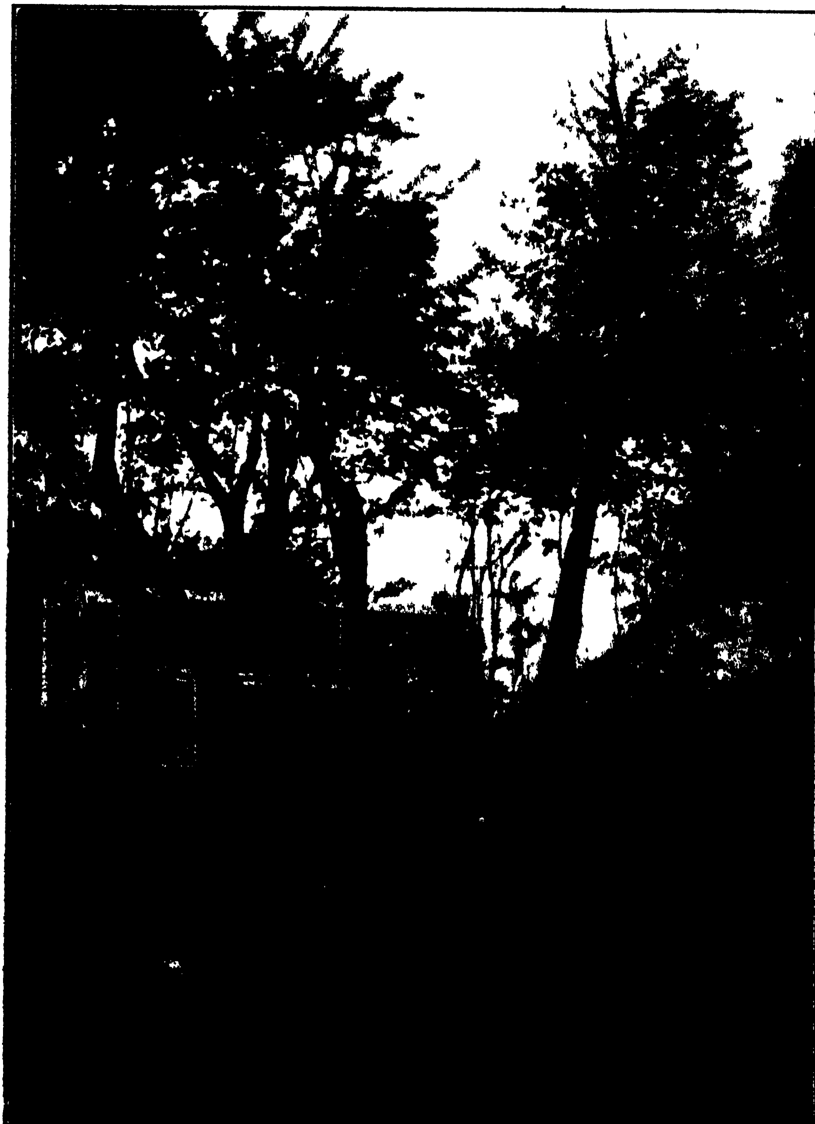
SHELLY BAY; MANGROVE AND CEDAR



Ancient Olive Tree, Somerset I

A. Hyatt Verrill, Phot.

Gill Eng. Co.



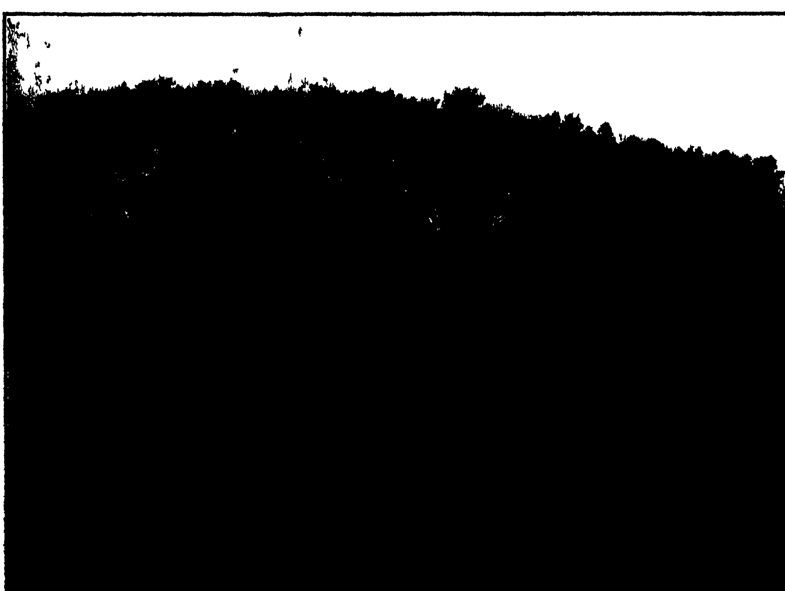
A. Hyatt Verrill, Phot. Gill Eng. Co

FIDDLE-WOOD TREE AT PAYNTER'S VALE.

HARRINGTON SOUND.

A. Hyatt Verrill, Phot. Gill Eng. Co.

1



A. Hyatt Verrill, Phot. Gill Eng Co.

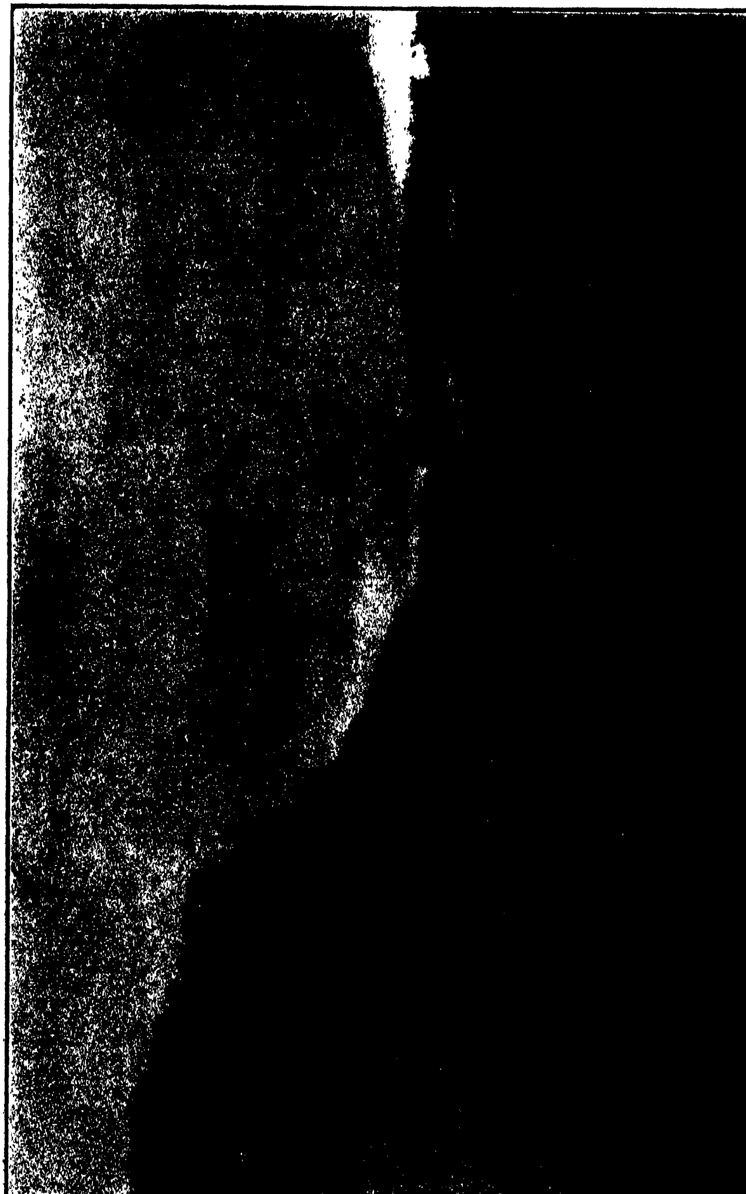
TROPIC BIRD; CLIFF ON HARRINGTON SD

A. Hyatt Verrill, Phot. Gill Eng. Co.

SHARKS HOLE; CEDARS.

. Hyatt Verrill, Phot. Gill Eng. Co.

MANGROVES ; BANANAS.

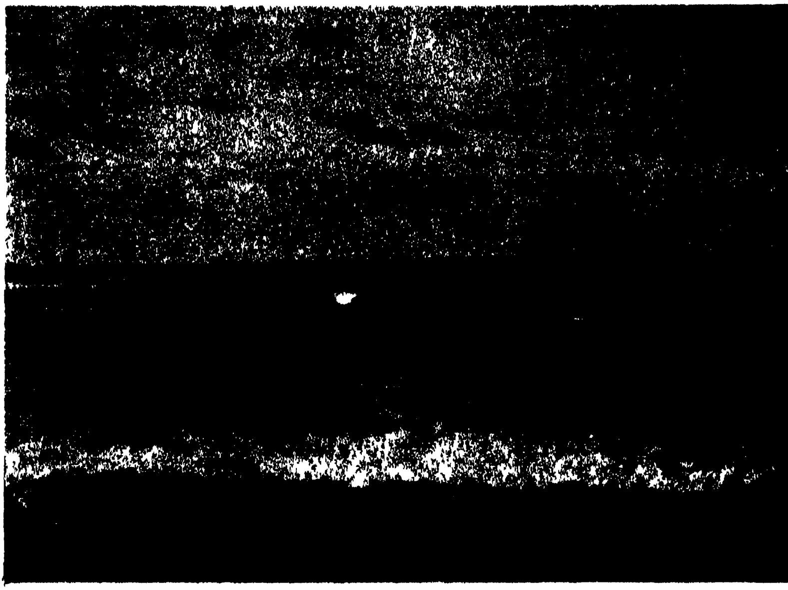


SAND DUNES NEAR TUCKER'S TOWN.

A. Hyatt Verrill, Phot. Gill Eng. Co.

SAND DUNES NEAR TUCKER'S TOWN.

A. Hyatt Verrill, Phot. Gill Eng. Co.



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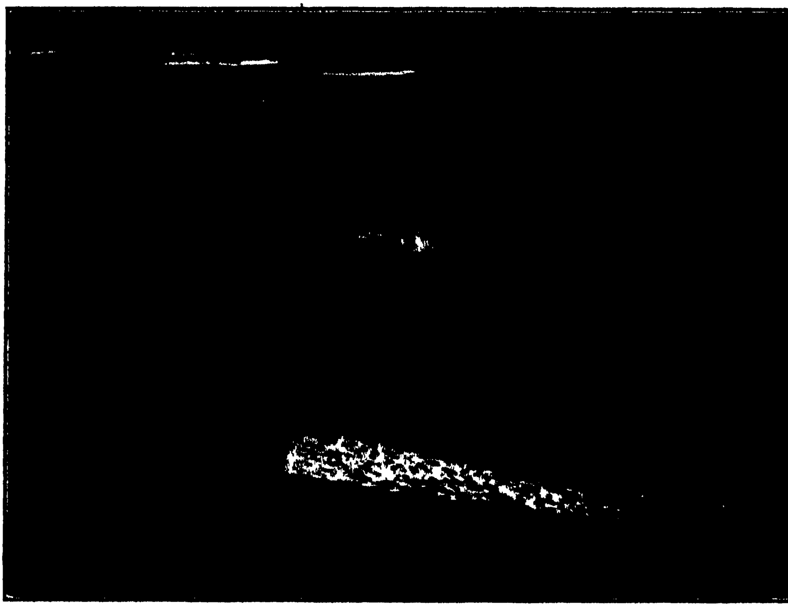
A. Hyatt Verrill, Phot. Gill Eng. Co.

SERPULINE ATOLLS OR BOILERS.

Serpuline Atolls or Boilers

A. Hyatt Verrill, Phot. Gill Eng. Co.

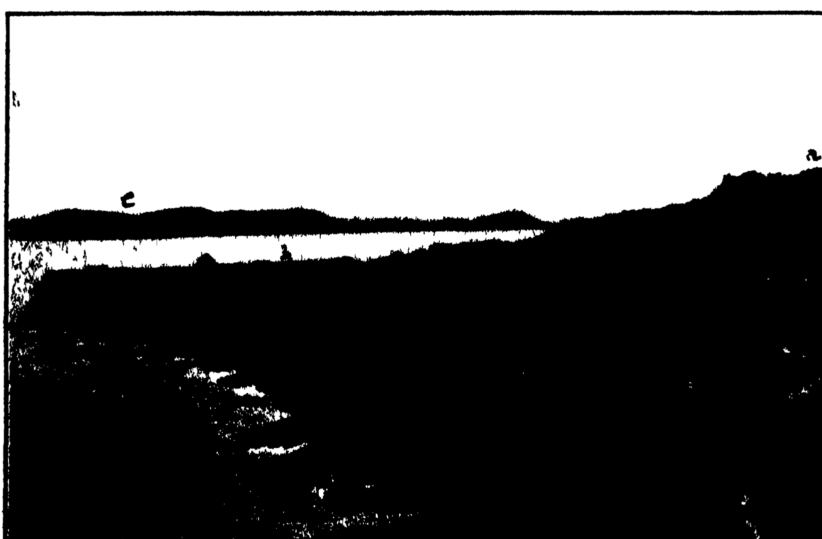
1



A. Hyatt Verrill, Phot Gill Eng. Co.

RUINS, GURNET HEAD, CASTLE I., PROFILE OF GURNET HEAD

1



A. Hyatt Verrill, Phot. No. 2. Gill Eng. Co.

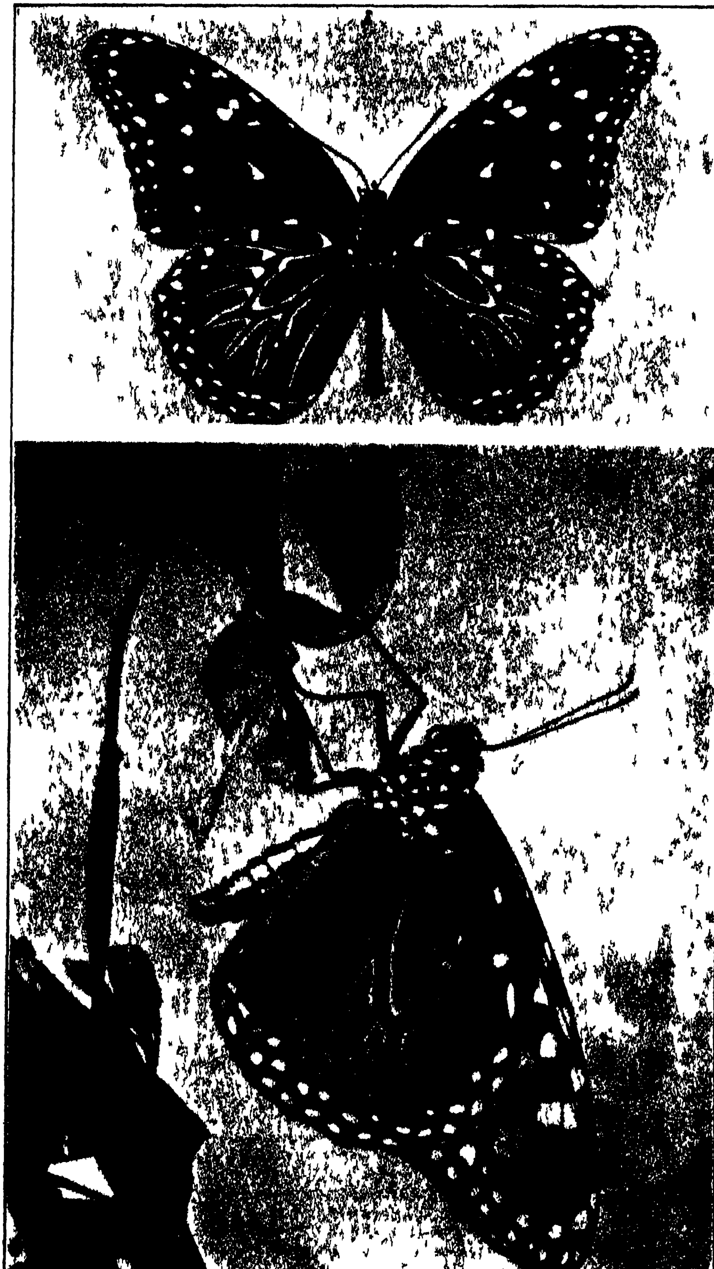
Rocks, Tobacco Bay; Ruins, Castle I.

A. Hyatt Verrill, Phot. Gill Eng Co

CRESPHONTES BUTTERFLY

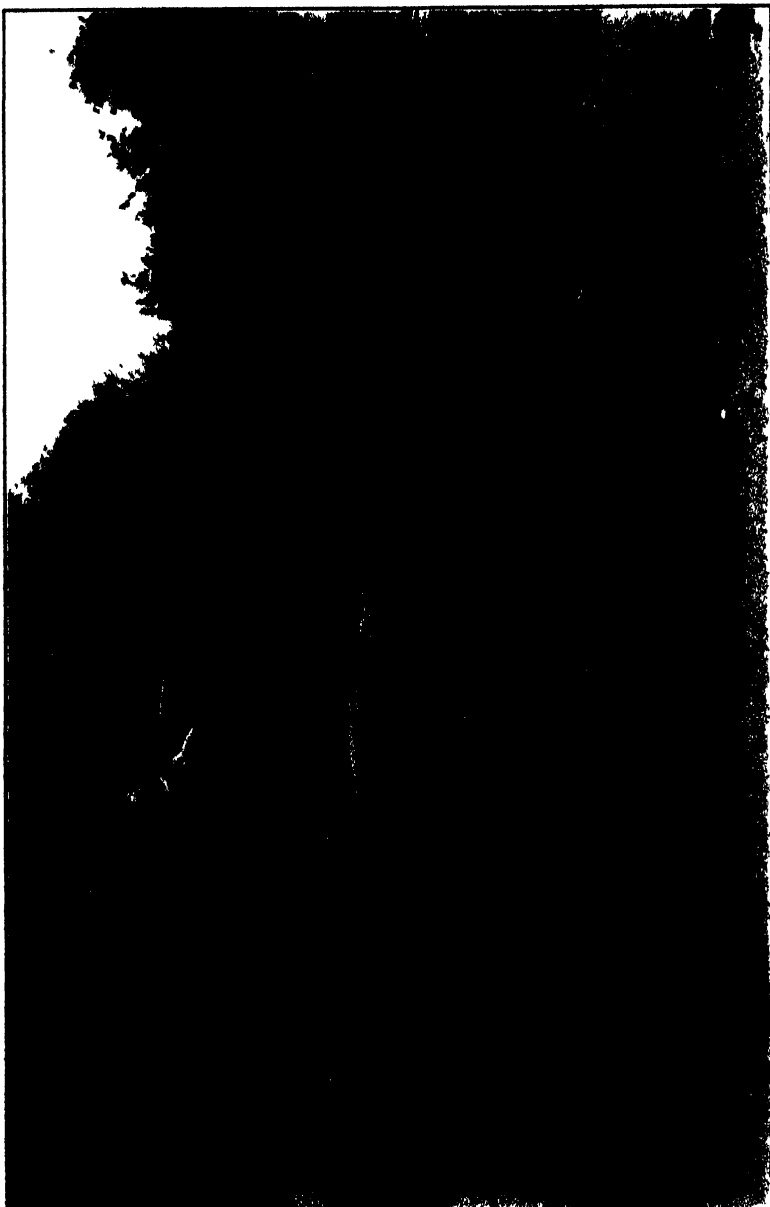
A. Hyatt Verrill, Phot. Gill Eng Co

MONARCH BUTTERFLY AND VICEROY



A. Hyatt Verrill, Phot Gill Eng. Co

QUEEN BUTTERFLY AND MONARCH.



CLIFF NEAR HUNGRY BAY

A. Hyatt Verrill, Phot.

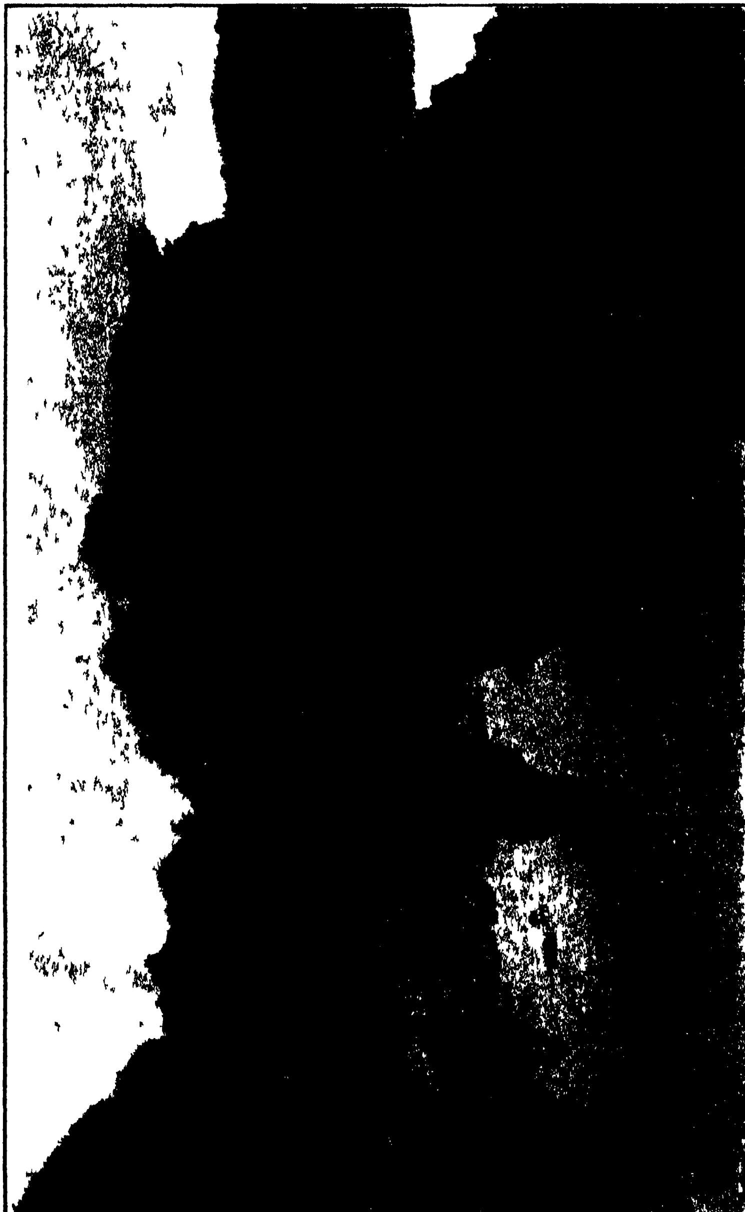
Gill Eng. Co.

FOSSIL "PALMETTO STUMPS."

A. Hyatt Verrill, Phot. Gill Eng. Co.

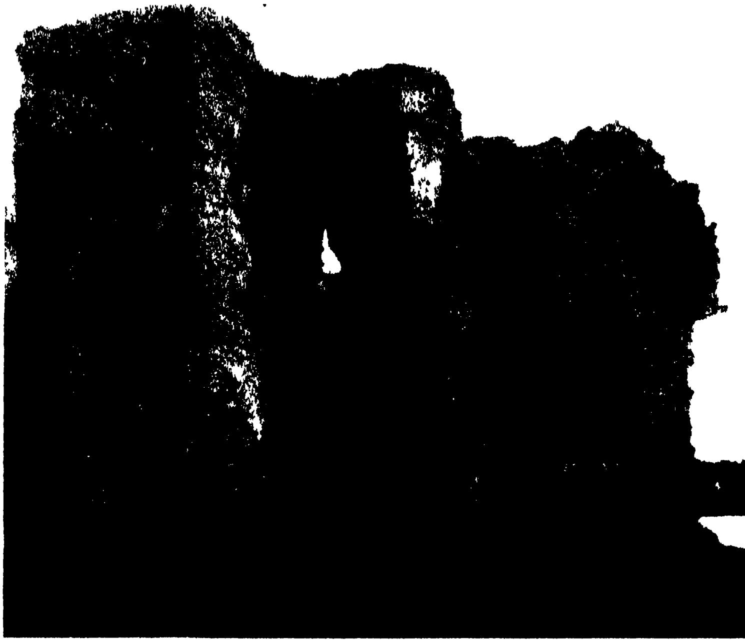
FOSSIL CASTS OF "PALMETTO STUMPS"

A. Hyatt Verrill, Phot. Gill Eng Co

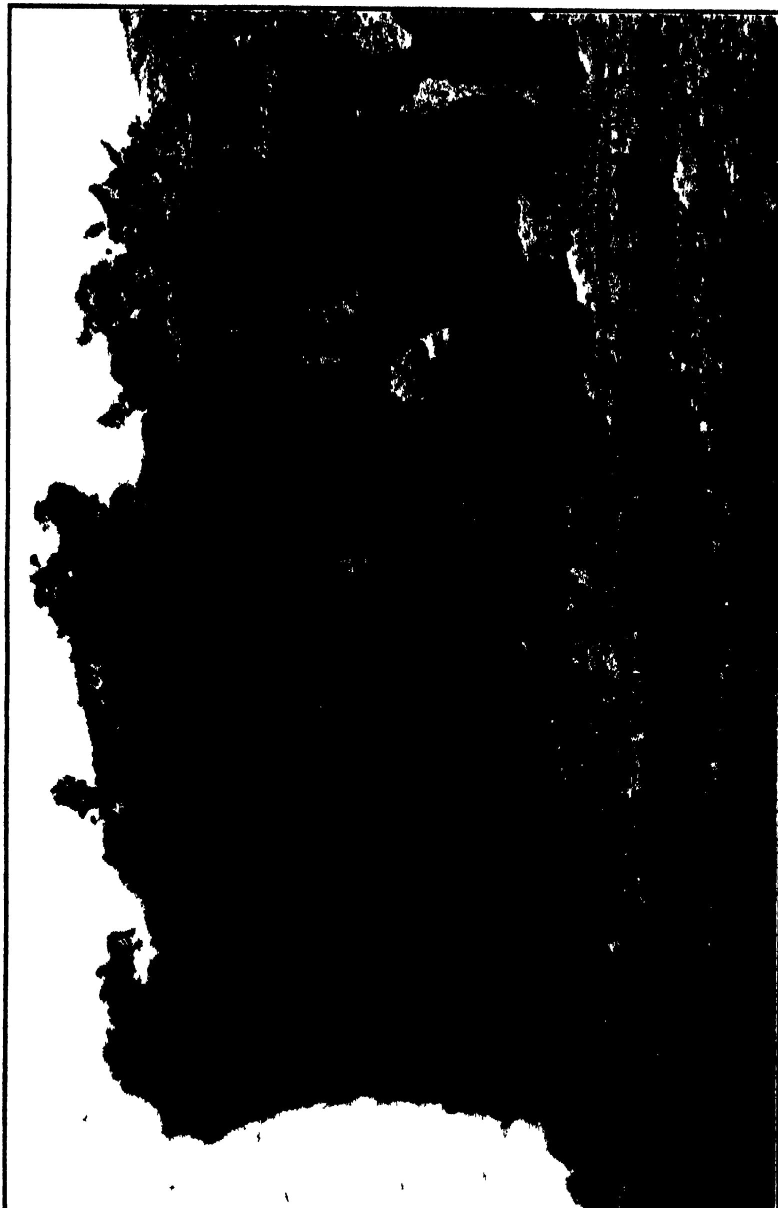


Natural Arches, Tucker's Town

A. Hyatt Verrill, Phot Gill Eng Co.



A. Hyatt Verrill, Phot. No. 1; J. B. Heyl, No. 2.
CATHEDRAL ROCKS; CLIFFS, SOUTH SHORE, WITH POT-HOLE.

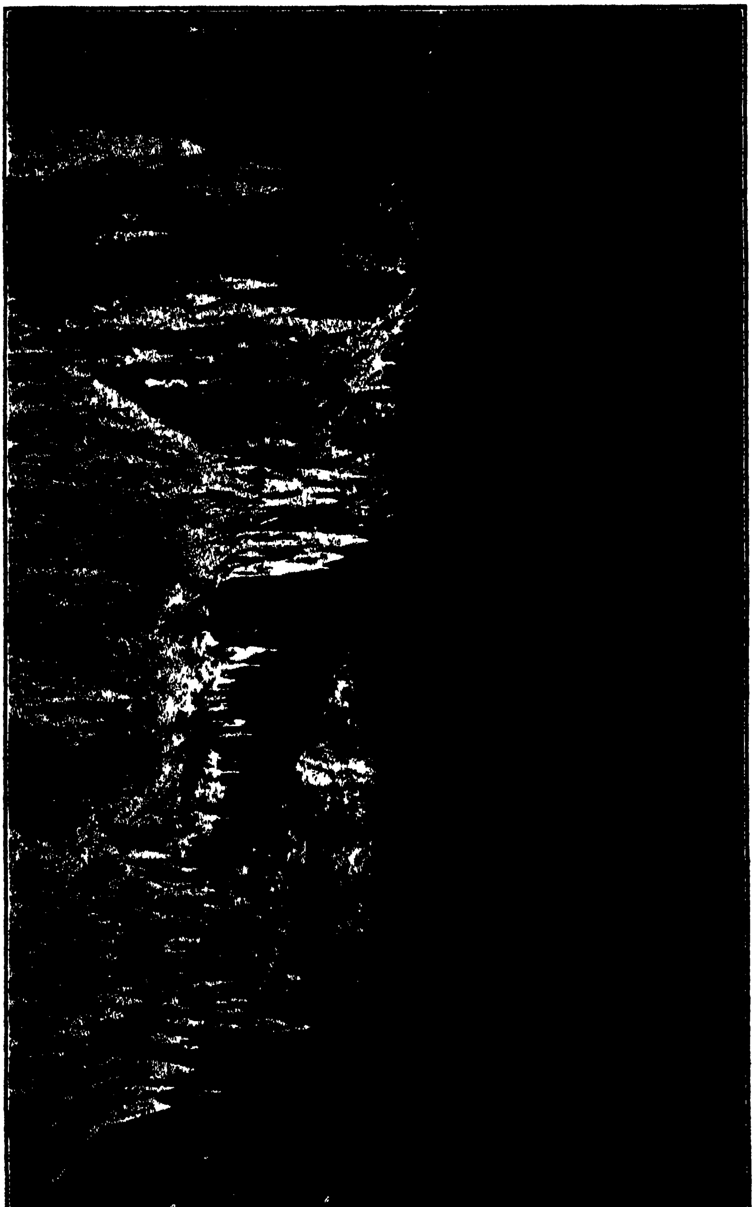


CATHEDRAL ROCKS

A. Hyatt Verrill, Phot. Gill Eng. Co.

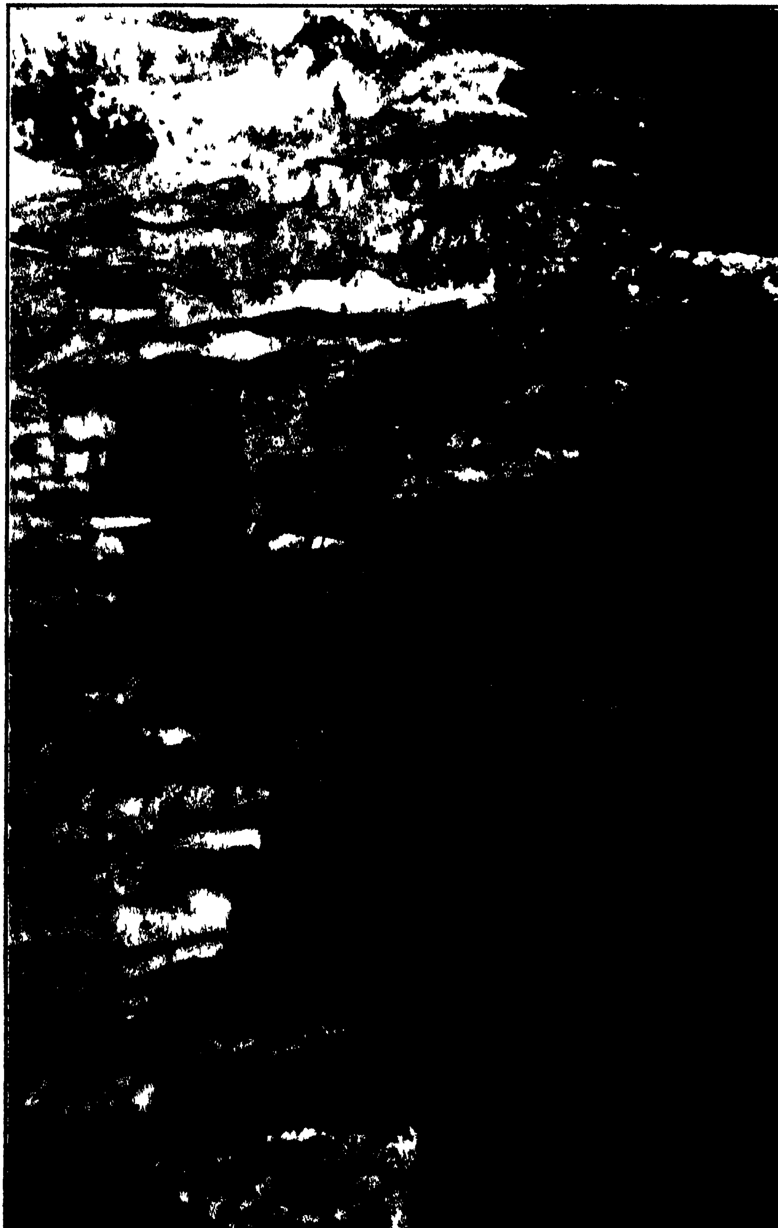
Gill Eng. Co.

WALSINGHAM CAVE; TOBACCO BAY.



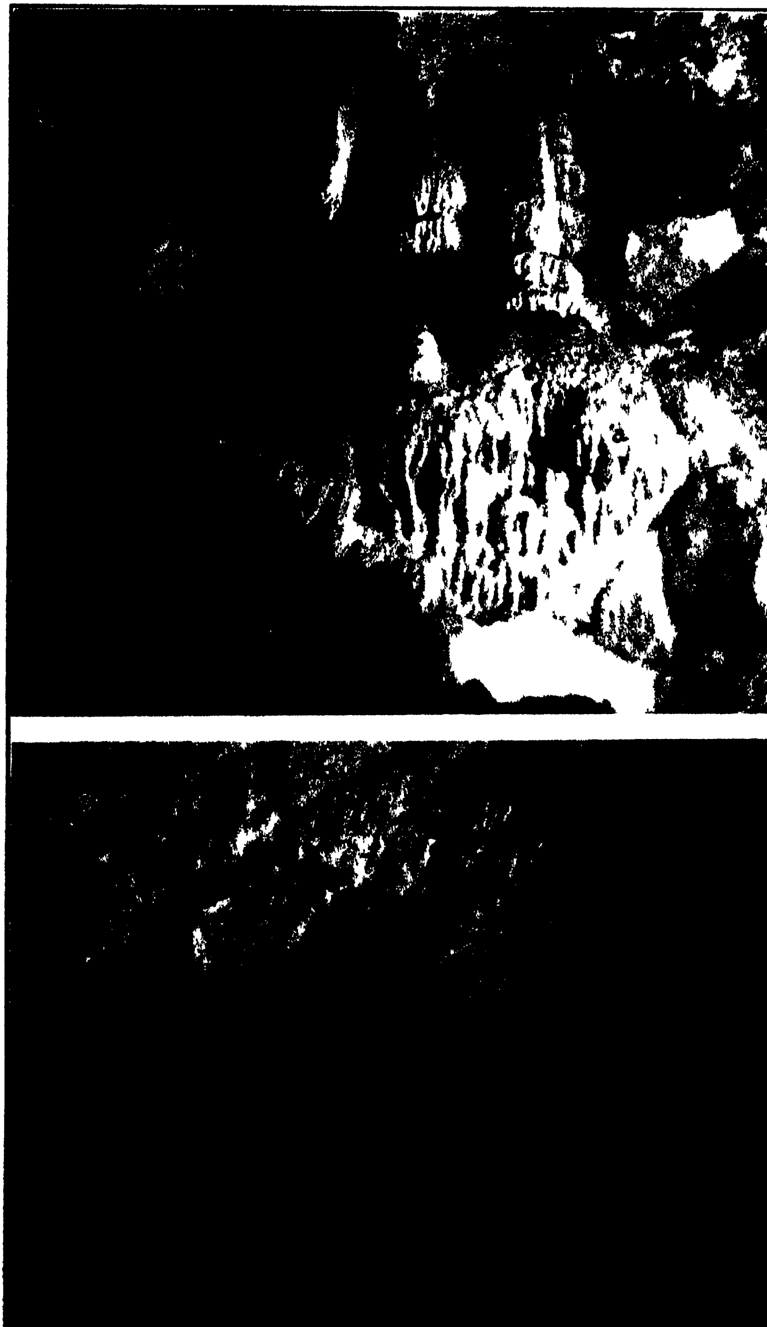
Walsingham Cave.

A. Hyatt Verrill, Phot. Gill Eng. Co.



A WALSINGHAM CAVE

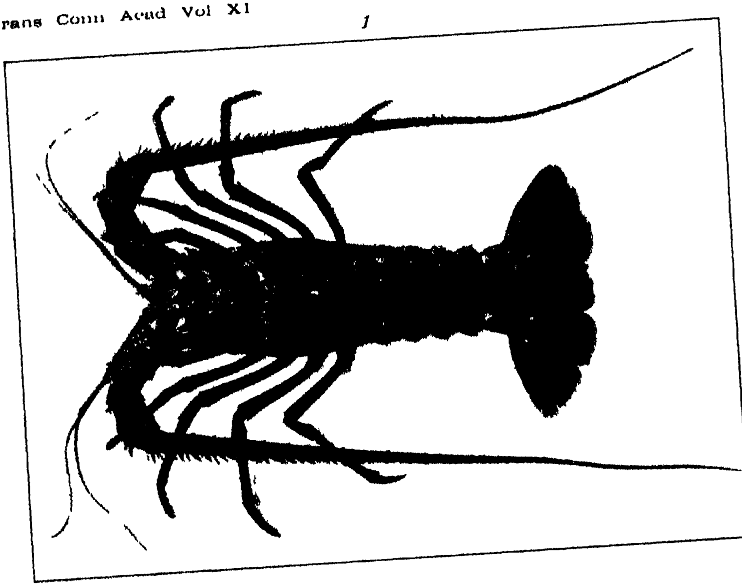
A. Hyatt Verrill, Phot. Gill Eng. Co



A. Hyatt Verrill, Phot Gill Eng Co

PENISTON'S CAVE

1

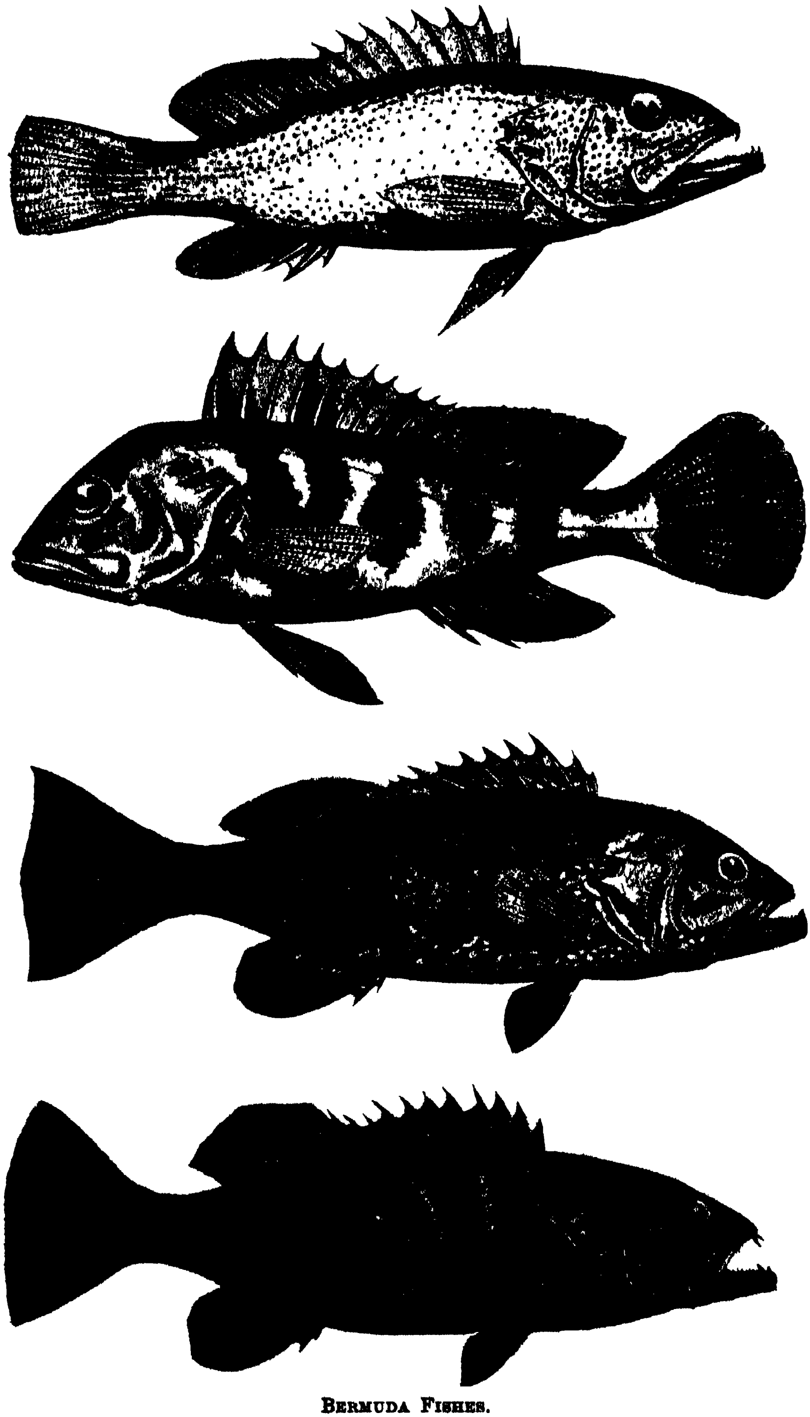


2

Gill Eng. Co.

A. Hyatt Verrill, Phot. and drawing.

BERMUDA LOBSTER; OCTOPUS, ETC



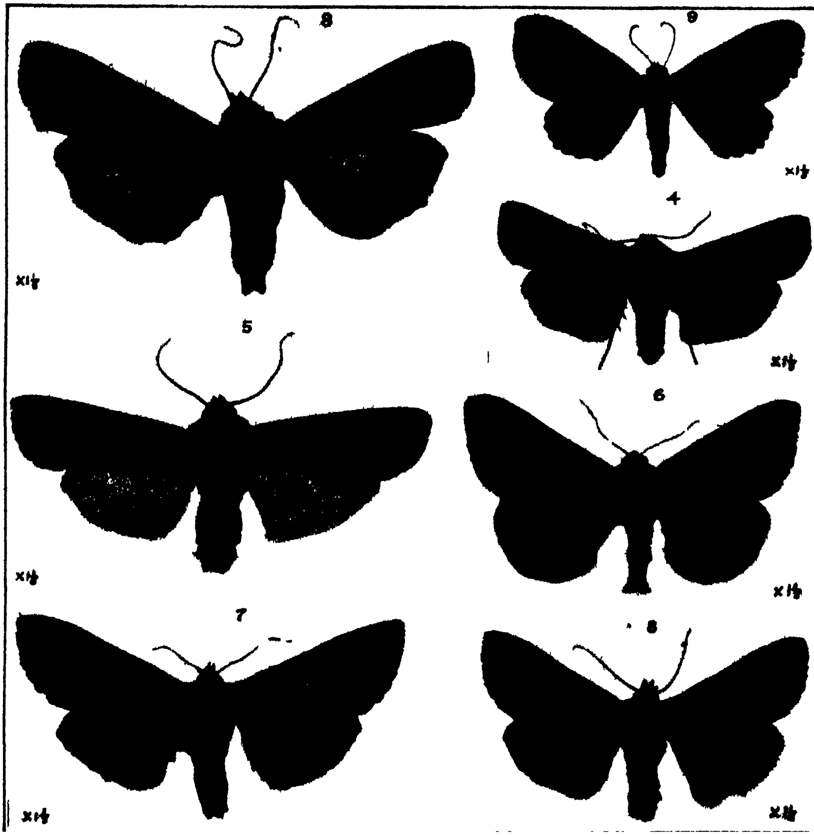
BERMUDA FISHES.

A. Hyatt Verrill, Phot. Gill Eng. Co.

BERMUDA AND AMERICAN CICADAS; ORANGE SCALES.

A. Hyatt Verrill, Phot. Gill Eng. Co.

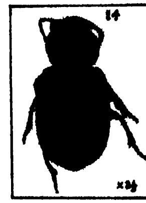
SWEET-POTATO SPHINX.



A. Hyatt Verrill, Phot. Gill Eng. Co.

BERMUDA INSECTS.

15



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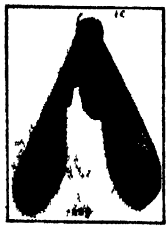

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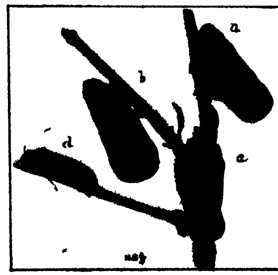

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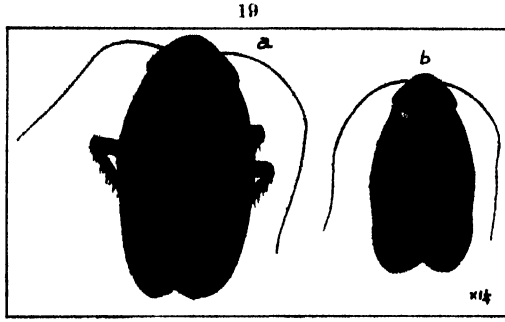

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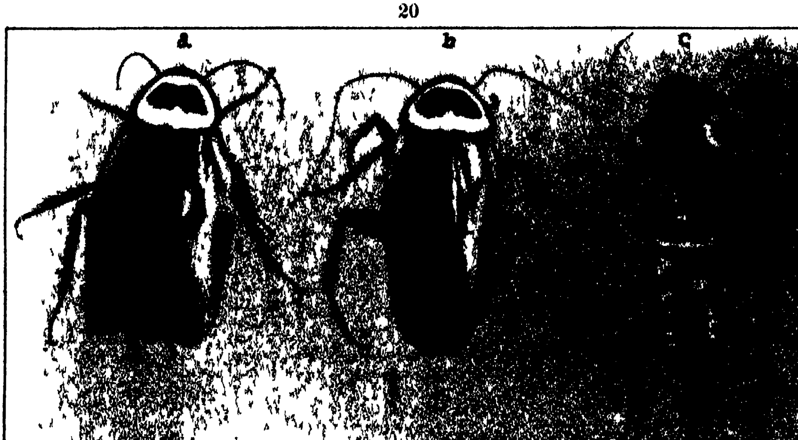
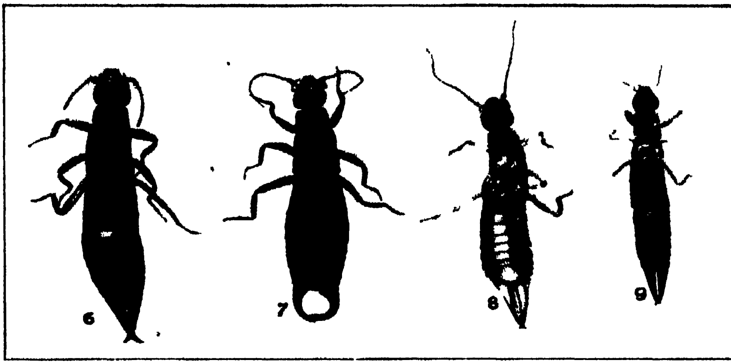


A. Hyatt Verrill, Phot.

Gill Eng Co.

BERMUDA INSECTS



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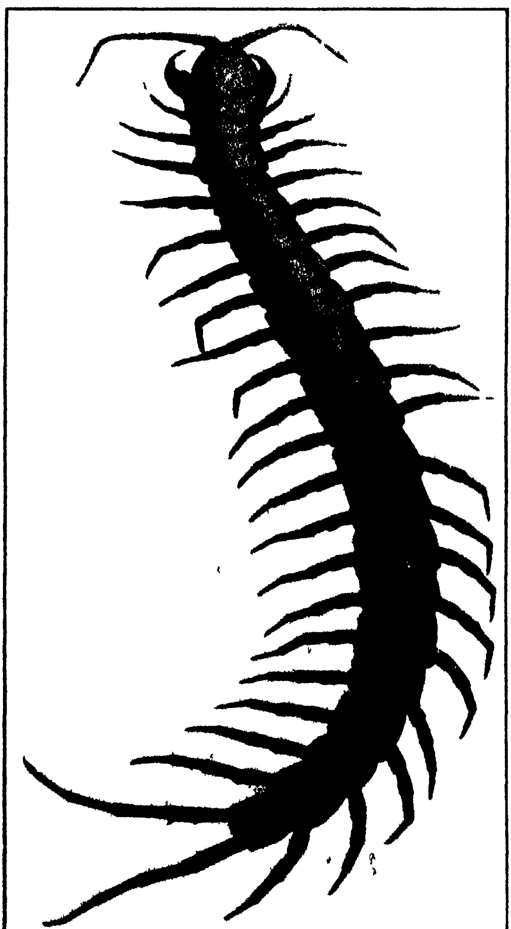

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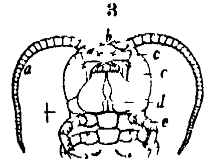

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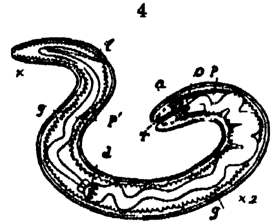
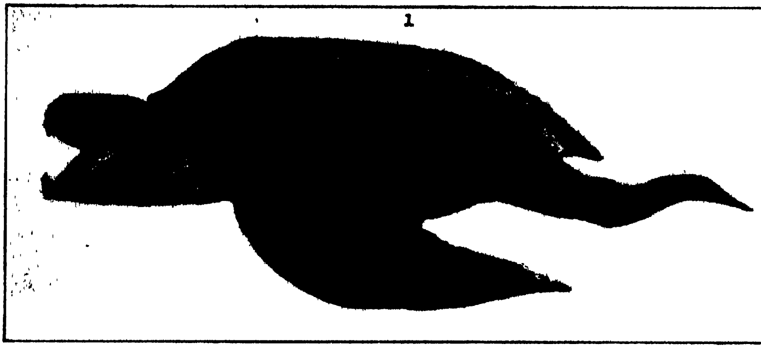


A. Hyatt Verrill, Phot. Gill Eng. Co.

INSECTS ; CENTIPEDES, ETC.

1



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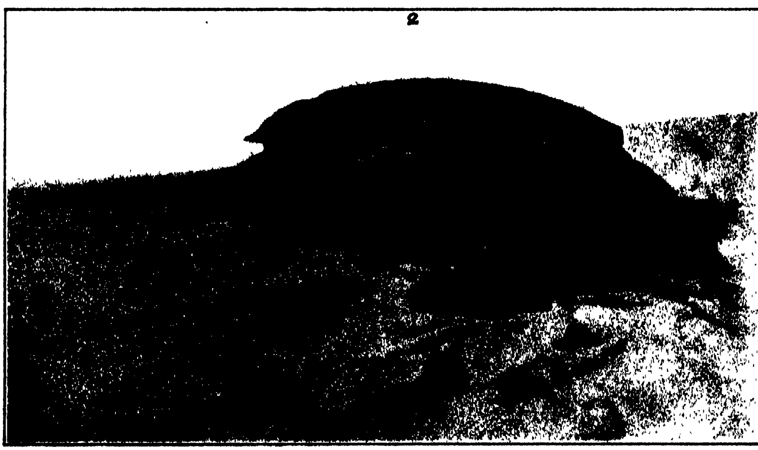

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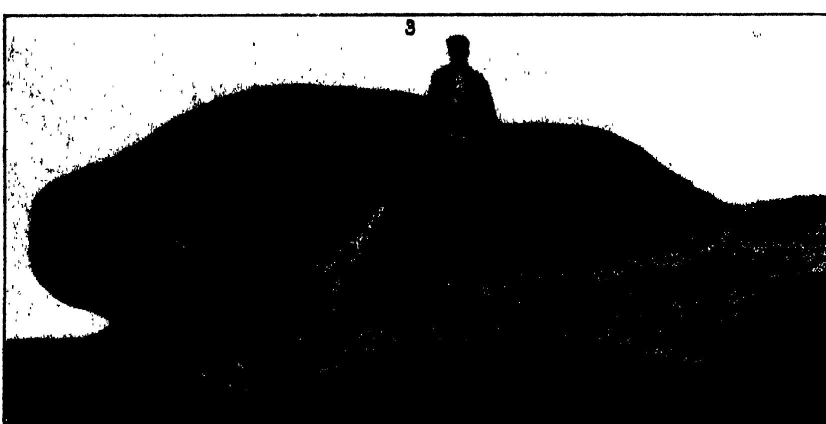


L. Mowbray, Phot., 1, 3. Gill Eng. Co.

SEA TURTLES; SPERM WHALE.

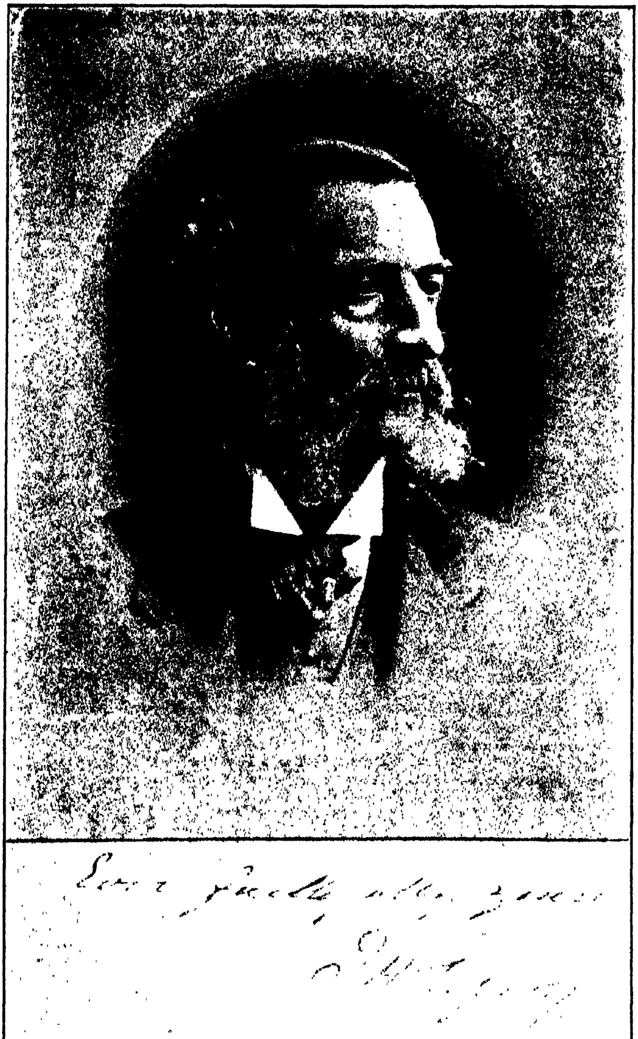
ADMIRAL GEORGE SOMERS.

THE "FATHER OF BERMUDA."

1554-1610.

CAPT. JOHN SMITH, IN 1616.

1579-1632.



Notman & Fraser, phot. 1877.

GOVERNOR JOHN H. LEFROY.